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ABSTRACT

This four-chapter resource book provides both general and specific state-of-the-art information on the various technologies and strategies available to educators of physically handicapped students in "regular" junior/senior high school and college science classrooms. It provides information about accommodating students with physical impairments so that they may function in a manner as similar as possible to their non-handicapped peers within the educational system. Chapter I introduces the book by considering the special needs of the disabled student in the regular classroom, examining the purpose and structure of the book, and outlining science teaching goals and methods. Chapters II, III, and IV focus, respectively, on the hearing, visual, and motor/orthopedically disabled. Each chapter includes sections which discuss the nature and general causes of the impairment and general facilitative strategies. In addition, each chapter includes a section with a list of mitigative strategies keyed to the seven common teaching methods in science. These methods include teacher presentation, laboratory exercises, reading assignments, discussion and group work, audiovisual/tactile techniques, research problems, and field trips. (JN)

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RESOURCE BOOK

TEACHING THE PHYSICALLY DISABLED IN THE MAINSTREAM SCIENCE CLASS AT THE SECONDARY AND COLLEGE LEVELS

by

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PREFACE

This book was undertaken for two reasons. First, many teachers have contacted the American Association for the Advancement of Science (AAAS), The Foundation for Science and the Handicapped (FSH), and the Science and Handicapped Association (SHA) about information concerning methods and strategies of teaching science to physically disabled students in the regular classroom. Second, the draft information for this book was found to be very useful in the 1981 NSF Teacher Training Project on Mainstreaming the Physically Handicapped in Science held at the Marine Science Consortium, Wallops Island, VA.

The editor and members of the writing staff have been associated with one or more of the Student Science Training Programs in Marine Science for the Physically Handicapped. This program operated from 1977 to 1981, also, at The Marine Science Consortium. Working each summer with a group of 25 ± physically disabled students (motor/orthopedic/visual/hearing impaired) in a lecture/laboratory/field/research mode has given the writing group a wealth of experiences to draw upon. In the words of one of the co-editors, Dr. Lockard, "these valuable experiences and strategies, gained over a five-year period, must be shared with a science education community that desperately needs this type of information."

Funds for this book were supplied, in part, by the NSF Project SPI 81-00966.

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EDITOR'S NOTE

Throughtout the text we have used masculine pronouns. In the early versions of this resource book we used joint pronouns such as (s)he, his/her, etc. However, early reviewers (both females and males) indicated that this unconventional terminology greatly interfered with the readability of the text. The authors concurred with the advice of these reviewers. We hope that a satisfactory system of non-sexist pronouns will soon be established.

During the planning and writing of this resource book, considerable discussion arose concerning organization and what topics to include or exclude—for instance, how to incorporate Bloom's taxonomy; how to indicate changing mitigative strategies as a function of severity of disability; how to define the meaningful set of disabilities, etc. The present document represents what we believe to be a useful compromise on these matters.

We had originally included material on mitigative strategies for testing in science; however, since there already exists a final draft of a publication of the Science for the Handicapped Association, "Testing Physically Handicapped Students in Science: A Sourcebook for Teachers", we decided that the addition of testing topics in this book would be both redundant and wasteful of resources.

Within the text we have used bold italic type to indicate terms or items which are not defined in the text, but are defined in the glossary. Bold face roman type is used for emphasis.

We urge users of this book to forward ideas, corrections, strategies not included herein, and other information to the editor[1] which will make the second edition considerable more useful to the teachers and the disabled population of students in science education.

E. C. K., Jr.

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CHAPTER I

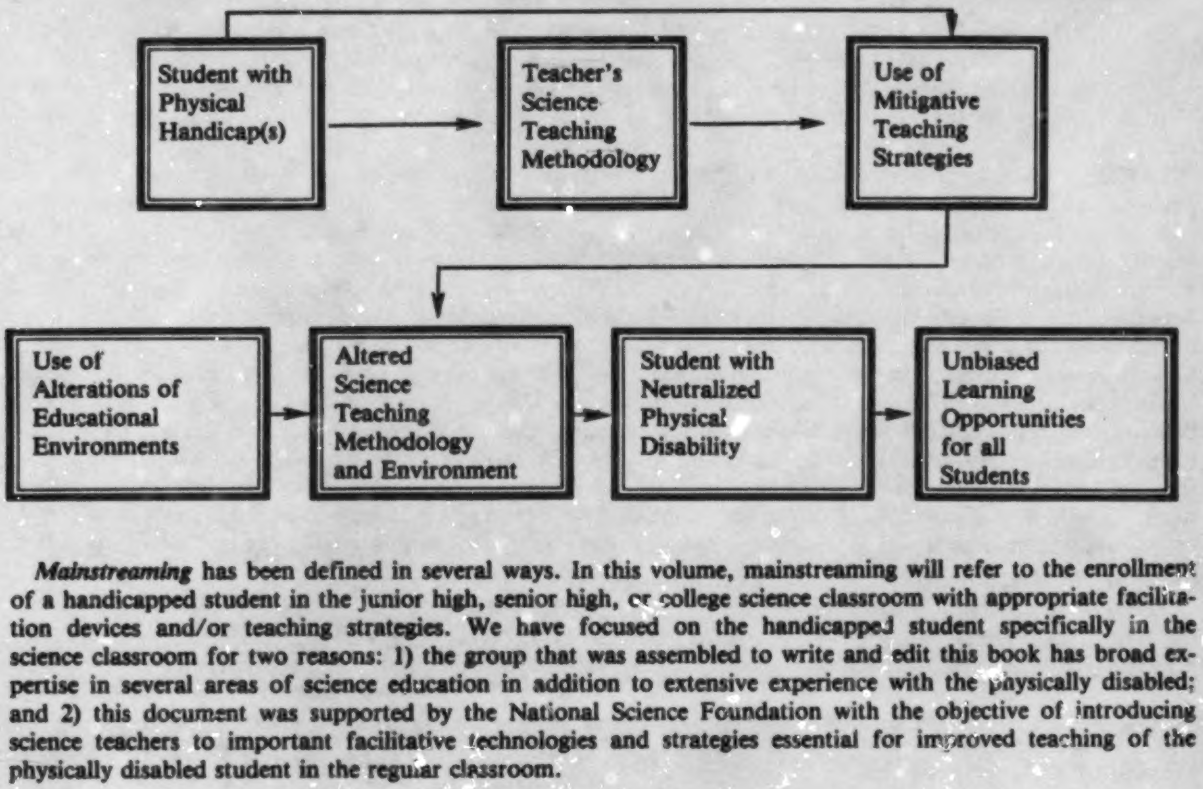
TEACHING THE PHYSICALLY DISABLED IN THE MAINSTREAM SCIENCE CLASS

INTRODUCTION

Physically handicapped students are individuals who just happen to have disabilities. These individuals have the same educational needs and/or problems as other students. They also happen to have other problems. The instructor of a disabled student must recognize the joint aspects of these two kinds of problems in teaching the handicapped student. Teachers and their disabled students should also remember that virtually every disability and teaching situation has been faced previously. This resource book is a guide to effective strategies used in previous situations.

This resource book provides both general and specific state-of-the-art information on the various technologies and strategies available to the educators of physically handicapped students in the "regular" science classroom. It provides information about accommodating students with physical impairments so that they may function in a manner as similar as possible to their non-handicapped peers within our educational system.

Providing solutions to problems of teaching science in a classroom in which one or more students have a physical disability may best be seen through a schematic diagram (below). The diagram includes the student (with a physical impairment), the teacher (with his teaching methods and objectives), the types of mitigative strategies that are available, and the goal of learning opportunities that are not biased by the impairment.


Student with Physical Handicap(s)
Teacher's Science Teaching Methodology
Use of Mitigative Teaching Strategies
Use of Alterations of Educational Environments
Altered Science Teaching Methodology and Environment
Student with Neutralized Physical Disability
Unbiased Learning Opportunities for all Students

Mainstreaming has been defined in several ways. In this volume, mainstreaming will refer to the enrollment of a handicapped student in the junior high, senior high, or college science classroom with appropriate facilitation devices and/or teaching strategies. We have focused on the handicapped student specifically in the science classroom for two reasons: 1) the group that was assembled to write and edit this book has broad expertise in several areas of science education in addition to extensive experience with the physically disabled; and 2) this document was supported by the National Science Foundation with the objective of introducing science teachers to important facilitative technologies and strategies essential for improved teaching of the physically disabled student in the regular classroom.

Mainstreaming is an effective educational process for some handicapped students; it has been less so for others (Bishop, 1979). Unfortunately, teachers, administrators, and special educators have been called upon to integrate physically handicapped individuals into current educational programs without adequate information, training, experience, or self-confidence (Keller et al., 1978:79). Many of these educators are compelled by parents, and by the law, to prepare *individual educational programs* (I.E.P's) describing needed resources and teaching strategies for the mitigation of the students' handicaps in their educational environments. But many instructors are unaware of existing mitigative strategies to aid in the accommodation of physically handicapped students in their classrooms.

The methodologies of mitigation for a specific physically impaired student are generally similar over a range of educational levels. However, the decisions involved in choosing and implementing appropriate mitigative strategies are usually handled differently among these levels. Depending on school size and financial resources, the junior high and, to some extent, the senior high school levels rely on the in-class teacher and or the special education unit, or teacher, for these mitigative outcomes. Community and small colleges mainly rely on the in-class instructor and the health office. In larger colleges and universities most of these facilitive outcomes are handled by an office of disabled student affairs. Through these offices the professors can receive advice and assistance and the facilities necessary for the appropriate adaptations and alterations.

The pertinent laws and their associated regulations are: Public Law 94-142 (The Education for All Handicapped Children Act of 1975) and Section 504 of the regulations promulgated in 1977 under the Rehabilitation Act of 1973. Two pertinent sections of these laws are:

> "It is the purpose of this Act to assure that all handicapped children have available to them...a free appropriate public education which emphasizes special education and related services designed to meet their unique needs, to assure that the rights of handicapped children and their parents or guardians are protected, to assist States and localities to provide for the education of all handicapped children, and to assess and assure the effectiveness of efforts to educate handicapped children." (P.L. 94-142, U.S. Congress, 1975).

Further,

> "No otherwise qualified handicapped individual in the United States...shall, solely by reason of his handicap be excluded from participating in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving federal financial assistance." (Section 504, Rehabilitation Act, U.S. Congress, 1973).

To many individuals it remains unclear whether mainstreaming is considered to be an educational process or the goal of these federal laws (Bishop, 1979). Regardless of the point of view, P.L. 94-142 refers to **appropriate education** for all handicapped children, and it refers to individualized education programming, thereby clearly recognizing the specific educational needs for each handicapped student in the **least restrictive educational environment.** Further, mainstreaming is considered, by many, to be the first of several educational alternatives and is clearly not considered to be the remedy for all disabled students (Stuckless and Castle, 1979). In general, P.L. 94-142 covers the education of handicapped students from ages 3 to 18, while Section 504 of the 1973 Rehabilitation Act covers all ages—hence these latter regulations are applicable at the university/college level. The Rehabilitation Act further states that an institution receiving federal funds must assure that no handicapped person is denied educational benefits or is otherwise subjected to discrimination because of the absence of educational auxiliary aids for students with impaired sensory, manual, or speaking skills (Stuckless and Castle, 1979). The National Association of College and University Business Offices (1 DuPont Circle, Washington, D.C.) has produced an interpretative document, "Issues and Answers for Implementing Section 504" for use by college and university personnel. Some topics in that document directly bear on the auxiliary aids needed for the facilitation of physically disabled students in the mainstream college/university environment.

Bishop (1979) points out that mainstreaming is one aspect of a continuum of educational processes leading toward the overall goals of education in general (viz., "to prepare a student to earn a living and to live a life"). For elementary and secondary schools, a set of educational processes for disabled students has existed, but little emphasis on mainstreaming in the regular classroom has been given in past decades. In the past, the special needs of the physically handicapped in higher education have largely been ignored. Only with "prodding" (via the 1977 504 regulations of the 1973 Rehabilitation Act) has there been a "turn-around" in awareness concerning the needs of the physically handicapped person in higher education.

Bishop (1979) listed the following generally recognized educational approaches for the physically impaired. Note that these processes are listed in descending order with respect to "regular" classroom interaction as well as to the degree of mainstreaming of the physically impaired student. These approaches are generally applied to the elementary and secondary educational levels, but (except for 10) can act as a guide at the college level.

1) The physically handicapped student is placed in a regular class.
2) A consultant works with the teacher who has a physically handicapped student(s) in the classroom.
3) An itinerant teacher who has special skills and who rotates among the schools assists the physically handicapped student.
4) The physically handicapped student and his teacher use a resource room which provides auxiliary aids and materials.
5) The physically disabled student attends both the regular classroom and a special classroom.
6) The physically disabled student attends both the regular classroom and a special school.
7) The physically disabled student attends special classes only.
8) The physically disabled student attends special schools only (regular home visits).
9) The physically disabled student is instructed at home.
10) The physically disabled student is excluded from instruction.

Generally, the basic requirements for an optimal teaching environment are: an effective teacher, a motivated student, and a good facility. We believe, however, that modifications must occur in these basic requirements. The educational environment must also address the special educational and educationally related social needs of physically disabled students.

Information pertaining to the students' handicap should be utilized in designing the appropriate mitigative teaching methods or strategies needed to neutralize the students' handicaps. The teacher needs to have relevant information about the disabled students' medical, psychological, educational, and social needs in order to implement appropriate education experiences. For example, some disabilities require that certain physical activities be precluded for particular individuals, whereas other disabled individuals may derive considerable benefit from such physical activities (Hatlen, 1973).

SPECIAL NEEDS OF THE DISABLED STUDENT IN THE REGULAR CLASSROOM

A student with a physical disability may have deficiencies in educational background, limitations in experience, or an inability to perform common life functions "normally." As a result, the disabled student often has special needs over and above those of his non-handicapped peers. These needs are not generally related to intellect or mental ability, but they often affect educational processes. It is our belief that almost all physically disabled students have special needs to some extent, depending upon such factors as rehabilitation success, efficacy of medication, and the degree of disability.

In order to effectively accommodate and teach the disabled student, an instructor should have an understanding of the disability as well as its ramifications in the educational setting. For this reason we have included sections on disability in the first part of Chapters 2, 3 and the second part of Chapter 4. In addition, the disabled student must have ample **opportunity to communicate,** via all modes of communication available to him. This opportunity is of utmost importance in the transfer of science information, science concepts, and science technology. Optimal **access to the information** is also important for neutralizing specific disabilities, e.g., visual and vibro-tactile access for the hearing impaired, audio-tactile access for the visually impaired. **Opportunities for experiences** common to the non-disabled student may sometimes need to be programmed into a disabled student's "curriculum." **Experimental learning** is an important aspect of every student's maturation; however, the disabled student may not have been exposed to much of this type of learning in everyday living and it is rarely "built into" the curriculum taught in either the mainstream classroom or in special schools. Opportunities for experimental learning, however, should be provided. In addition, there are **incidental learning experiences** which involve those common life events which most non-disabled children and young adults experience while growing up. Certain deficiencies in incidental learning may be apparent in the disabled student. These students need to be included in the educational process in order to approximate those life events and experiences that his non-handicapped peers draw upon for adjunct educational information. The **development of self-esteem** and **successes in learning** are two areas that warrant special attention. These are critical in the maturation process of all students. But again opportunities for these experiences need to be assured since they may be lacking, to some degree, in many handicapped students. **Multi-level**

learning opportunities are needed in all learning situations but, again, may be lacking for the disabled student. All students must be able to deal with complex theoretical issues and be able to relate advanced topics of knowledge to concepts already learned. Multi-level learning opportunities should, therefore, be built into our educational experiences for the physically impaired. Finally, part of the overall strategy for the neutralization of disability in the mainstream educational environment is **providing successful role models** and promoting recognition that a physically handicapped student is just another student who happens to have a disability.

PURPOSE AND STRUCTURE: HOW TO USE THIS RESOURCE BOOK

It is the purpose of this resource book to provide detailed reference material on various mitigative technologies and educational strategies for science programs in the junior high, senior high, and college or university. We have provided a comprehensive reference document that covers the most common aspects of science teaching: teacher presentation, laboratories, field trips, group interaction, readings, research problems, and audio-visual/tactile. Other teaching methodologies are generally adaptations of these, and the mitigative strategies we provide can be adapted to these other teaching methods. Although the mitigative strategies and techniques presented here are intended for application in science courses, many will apply, either directly or indirectly, to most other areas of instruction.

The overall structure of the book is based on three broad categories of physical impairment: **hearing, visual,** and **motor/orthopedically disabled** (MIOD). These categories represent areas of the greatest concentration of current efforts concerning the mitigation of physical disabilities in the mainstream educational environment. One word of caution: excessive categorization leads to the stereotyping of students, their disabilities and the appropriate mitigative strategies--which we believe to be an extremely unproductive approach to mainstreaming. Each physically disabled student is unique; two students "stereotypically" classified into one of the above categories can have widely divergent capabilities and limitations and, thus, individual educational needs. Deno (1970) indicate that accomodation of the physically disabled in the regular classroom is maximized when:

1)There is close collaboration among school, community, state agencies, and special education units.
2)Regular school personnel are knowledgeable about and committed to adapting instructional services to the special needs of the physically handicapped.
3)Other students accept their physically disabled peers.
4)There is ease of accessibility of the mobility impaired students.
5)Specialized instruction is provided as required.
6)Special instructional materials and equipment are provided as needed.
7)Specialized and appropriate guidance and counseling is provided.

SCOPE

The choice of disabilities to be presented in this resource book was made on the basis of information concerning the major physical impairments. There are fourteen categories of disability which account for most of the disabled persons in the United States, according to Dudek et al. (no date). These fourteen categories have been re-classified into the following nine larger categories. Some common conditions belonging to each of the categories are given also.

1)Nervous system disorders
  - Traumatic spinal cord injury
  - Stroke
  - Cerebral Palsy
  - Epilepsy

2)Mental disorders
  - Mental retardation
  - Schizophrenia

3)Muscular-skeletal disorders
  - Rheumotoid Arthritis

4)Cardiovascular disorders
  - Coronary heart disease

5)Respiratory disorders
  - Emphysema

6)Digestive disorders
  - Cancer of the colon or rectum

7)Urogenital disorders
  - Kidney disease

8)Endocrine-metabolic disorders
  - Diabetes mellitus

9)Sense organ disorders
  - Hearing impairment
  - Visual impairment

Certain disabilities in the above categories, viz., stroke, coronary heart disease (we do include congenital heart disease), emphysema, cancer of the colon or rectum, and kidney disease, were not included in this book because of their low incidence in the target population. Neither do we address categories of mental or emotional disorders or learning disabilities. We also recognize that there exists a large number of administrative problems in providing special services to the disabled, but these are also beyond the scope of this book. The problem of the disabled student hiding his handicap is also recognized, but again space precludes our examination of this topic (this problem usually surfaces in other forms such as behavior or performance difficulties).

As stated above, our major disability categories are: hearing impaired, visually impaired, and motor impaired/orthopedically disabled and a full chapter is devoted to each category. In each of these chapters we describe briefly the nature of the disabilities themselves, since this background information will be helpful in understanding some of the mitigative strategies. Another section describes generalized facilitative strategies and technologies available for that category. These sections are essentially patterned after those presented in Teaching Chemistry to Physically Handicapped Students, published by the American Chemical Society (1981) and The College Student with a Disability: A Faculty Handbook, Published by the President's Committee on the Employment of the Handicapped (1980). In the chapter on the hearing impaired, the general strategy section may be of greater use to the instructor than the detailed last section of that chapter. The last section of each chapter presents specific mitigative strategies using tables that relate various kinds of disabilities to the appropriate mitigative strategies. In each case an example section (boxed in black) shows clearly how to use the tables. We recommend that the instructor read the entire chapter on the impairment of concern and then use the last section of that chapter to develop the appropriate mitigative strategies.

SCIENCE TEACHING GOALS

In order to assist teachers in relating specific mitigative teaching strategies to broader science educational goals, a summarizing outline of these goals is given below. A constant concern of the writers of this book is that, in teaching handicapped students one must be aware that the teachers' overall goals for all science students are the same - only teaching strategies are modified for students who have disabilities.

Summary Outline of Goals, Objectives, and Methods for Developing Science Literacy

General Goal - Students will acquire science information and science process skills.

General Objectives

The student will be able to appropriately:

1.Formulate hypotheses
2.Conduct literature searches
3.Design experiments
4.Use materials and equipment
5.Acquire data
6.Analyze data
7.Evaluate data
8.Formulate conclusions
9.Synthesize and communicate results
10.Apply scientific concepts and principles

General Methods and Aspects of Science Teaching

A.Teacher presentation
B.Active and passive laboratory work
C.Reading
D.Group interaction

E.Audio-visual/tactile
F.Research problem
G.Active and passive field trips

Other more specific objectives or methods are sometimes present in the process of science teaching, but the authors believe that the above list covers a majority of the situations in science education.

We believe that this book will be helpful to science educators since many educators have experienced a pressing need for this type of publication for several years.

Our experiences have taught us two important lessons about mainstreaming: (1) the teacher is the "role model" for behavior toward the disabled student—his attitude and how he reacts, communicates, and assists the disabled student will be the model for his students, and (2) the disabled student must offer advice, constructive criticism, and assistance to the instructor and to his peers regarding his needs.

CHAPTER II

THE VISUALLY IMPAIRED

SECTION I. THE NATURE AND GENERAL CAUSES OF VISUAL IMPAIRMENTS

Various visual impairments exist, each possessing its own set of characteristics and creating its own set of limitations and problems. Hence, there is no "typical" blind student. Likewise, the term "legal blindness" encompasses a wide range of visual problems and capabilities, ranging from total blindness to the ability to distinguish only beween darkness and light to greater kinds and degrees of vision. According to Foster et al. (1977), a person can be considered legally blind for one or both of the following reasons:

1) ***visual acuity*** (clearness of vision) of less than 20/200 in the better eye after correction. In other words, a legally blind person can only see clearly at 20 feet (with correction) what a person with "normal" vision can see clearly at 200 feet.

2. a ***field of vision*** of 20° or less. A normally sighted person sees about 180°. In other words, the field of vision is limited to a narrow angle.

As noted by Shapero et al. (1968), visual acuity depends on the sharpness of the retinal focus, the sensitivity of the nervous elements, and the interpretative faculty of the brain. Thus, a person's visual acuity can vary with such specific circumstances as the degree of general illumination, the background contrast, the size and color of the object, and the effect of the refraction of the eye on the size and character of the retinal image. So, for instance, a person may have usable vision in bright light but little or no usable vision in dim light or darkness; or, he may have usable vision in dim light, but little or no usable vision in bright light. Likewise, a person may have good ***central vision*** and little ***peripheral vision,*** or no central vision with good peripheral vision.

Furthermore, individuals with the same visual impairment may differ greatly in their ability to use their vision.

Age at the Onset of the Disability. The impairment itself is not the only consideration that must be taken into account when assessing a visually impaired individual (Lowenfield, 1973). A second factor is the age of the student at the onset of the visual problem. ***Visual imagery*** is defined by Shapero et al. (1968) as "the process of recalling actual past visual experiences," and it is a valuable resource for visually impaired students to draw upon in their learning processes (Lowenfield, 1973). A student who lost his vision before the age of five would not remember much about his former sense of sight. But a student who lost his sight later in life might be able to make important use of his greater visual imagery.

The Way in Which the Visual Impairment Occurs. The onset of blindness may occur slowly over a period of years as in the case of ***retinitis pigmentosa***[1] or quickly as in the case of an accident. A sudden loss of vision may cause the student to go into shock and withdrawal or cause other psychological problems. Also, the individual has no time to prepare for his visual impairment. On the other hand, blindness that is slow to develop may disturb the individual for a longer period of time, since he is apt to experience such emotions as fear, anxiety, despair, and anger (Lowenfield, 1973). The way in which visual impairment occurs affects each individual differently but may well have a significant impact on how the impaired person is able to use his vision.

The Anatomy of the Eye

The following section is paraphrased from The Eye and Vision by S. Howard Bartley, published by Grolier, Inc., Danbury, Connecticut (1978).

In general, the human eye functions much like a camera: light enters, is focused, and forms a "picture." (See Figure 1.) Light enters the eye by passing through a protective structure known as the ***cornea*** and then through a fluid-filled chamber containing a watery solution called the ***aqueous humor.*** The light then passes through the ***pupil,*** an opening in the center of the eye. Surrounding the pupil is the ***pigmented iris,*** which controls the size of the pupil and therefore determines the amount of light that passes into the interior of the eye. For example, in a dimly lit room the iris is wide open, enabling more light to enter the interior of the eye. In bright sunshine the iris constricts, leaving a very small opening. You can actually sense that your iris constricts if you turn on a bright light in a dark room.

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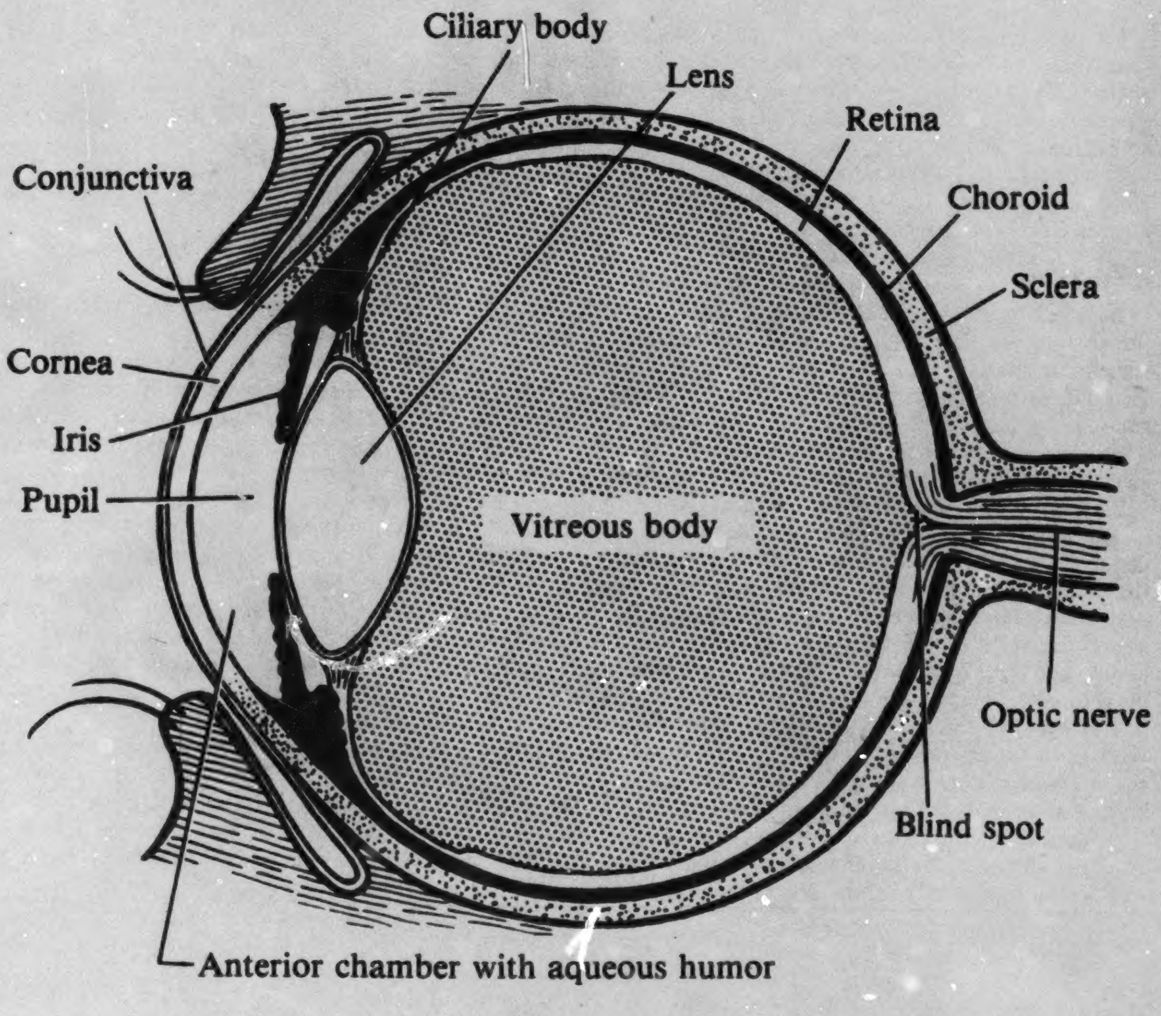
[1] See next section for description.

Figure 1. The Anatomy of the Eye.


Ciliary body
Lens
Retina
Conjunctiva
Choroid
Sclera
Cornea
Iris
Pupil
Vitreous body
Optic nerve
Blind spot
Anterior chamber with aqueous humor

Light then passes through the lens, whose main function is to bend, or focus, the light rays. Behind the lens is a second, larger fluid-filled chamber containing a jelly-like fluid called the *vitreous humor.* After passing through the vitreous humor, the light rays come to a focus on the *retina* at the rear of the eyeball. The image produced on the retina is inverted because of the lens, but the brain corrects the inversion.

The retina contains a large number of *rods and cones,* which respond to the light rays by sending impulses to the brain via the *optic nerve.* This is the sensation of sight. The rods and cones are distributed throughout the retina, but the distribution is not uniform. A small region in the center of the retina, called the *fovea centralis,* contains only cones. This area is one of keen vision. Progressing outward from the fovea centralis, the cones become more sparsely distributed, while the number of rods increases. The rods are of special importance when the eyes are functioning in dim light. At the spot on the retina where the optic nerve leaves the eye there are neither rods nor cones, which results in a *blind spot* at this site.

Major Visual Impairments

Retrolental fibroplasia (RLF) is a retinal disease that occurs in both eyes of premature infants who have been placed in incubators. It is caused by an excessive amount of oxygen during the first few days of life and can progress to total blindness within a few weeks (Vaughan and Asbury, 1977).

Retinoblastoma is a tumor that occurs in early childhood. It may develop in one or both eyes and usually remains unnoticed until it has grown large enough to be seen through the pupil (Vaughan and Asbury, 1977). This condition often results in the removal of the eye.

Retinal detachment occurs when the retina separates from the choroid layer. Since the choroid provides the needed cellular nourishment and oxygen, the retina will deteriorate after the separation. Detachment of the retina may occur in a matter of hours or over a period of years. The amount of vision that is lost depends upon the location of the rupture (Vaughan and Asbury, 1977).

Retinitis pigmentosa refers to a group of hereditary diseases that affect the retina. Retinitis pigmentosa usually occurs during early adolescence, and the first symptom is night blindness. Initially, peripheral vision is affected, creating "*tunnel vision.*" Later, central vision is affected, often resulting in total blindness when the individual is in his forties or later. Retinitis pigmentosa is often associated with other problems such as deafness or mental retardation. One such association combines pigmentosa, obesity, mental retardation, polydactylism (multifingers and/or toes), and hypogenitalism. This association is called the Laurence-Moon-Biedl syndrom (Vaughan and Asbury, 1977).

Albinism is the lack of pigmentation (melanin) in the body. Hair, eyelashes, and eyebrows are white. The iris and pupil are reddish. The individual is extremly light sensitive because light enters the eye through the iris as well as through the pupil. Associated with this is a poorly developed macula (center of the retina), which causes poor central vision. This poor central vision results in a rapid, involuntary movement of the eyeball *(nystagmus),* as the eye attempts to compensate for the poor central vision (Vaughan and Asbury, 1977).

Glaucoma refers to a group of diseases which are characterized by an abnormal increase in pressure within the eye. This pressure is great enough to cause damage to the optic nerve. In this case blindness can be prevented if treatment is started early. A severe type of glaucoma called "closed angle glaucoma" results from a blockage which restricts the flow of the aqueous humor. This blockage occurs when the iris is pressed against the lens, cutting off all aqueous outflow (Vaughan and Asbury, 1977).

Diabetic retinopathy is a disease of the retinal blood vessels. Its severity depends to a large extent upon the duration of the diabetes, and upon the degree of success in controlling the disease in the early years after onset. There are two types of diabetic retinopathy. The first is background retinopathy, which is characterized by the irregular flow and leaking of blood from capillaires in the retinal walls. A sensation of glare is the most common symptom. The second type is proliferative retinopathy, which is characterized by the growth of new blood vessels into the vitreous humor. Symptoms range from simple floating blind spots to total blindness, depending upon the site and degree of retinal damage (Vaughan and Asbury, 1977). Due to the poorer circulation of a diabetic person, there is also a lack of tactile sensitivity; thus, older persons (and younger persons after the onset of juvenille diabetes) blinded by diabetic retinopathy may have trouble learning braille and other tactile skills (Ricker, 1981a). This disease is one of the most common diseases causing blindness.

Cataracts are lens opacities—whitish areas in the lens—that interfere with vision. The opacities are often associated with aging, and some degree of cataract formation can be expected in persons over the age of 70. Cataracts may also result from trauma (a foreign object penetrating the eye and striking the lens). Congenital cataracts are less common; they are usually genetically determined but may occur in a fetus whose mother has contracted rubella (measles). When the interference of vision reaches the point that it restricts normal activities, surgery in the form of lens extraction is required. After the lens extraction, the individual must use: 1) *cataract*

glasses (which have extremely thick lenses), 2) ***corneal cataract lenses,*** or 3) ***intra-ocular lenses*** (Vaughan and Asbury, 1977). This disease is one of the most common diseases causing blindness.

Summary

Legal blindness covers a broad spectrum of visual disabilities. The extent of the visual disability depends upon the physical impairment of the student's eye, the age of the student at the onset of blindness, and the way in which that impairment occurred. Overcoming students' visual limitations requires unique and individual strategies based on a student's particular visual impairment.

SECTION II. GENERAL FACILITATIVE STRATEGIES FOR VISUALLY IMPAIRED STUDENTS

Science courses convey more than definitions, formulas, and classifications. Ideally, courses in science should foster scientific thinking, careful observation, and the accurate recording and analyzing of information as a way to reach conclusions. To some degree, science must be learned in the natural environment or in a laboratory rather than the classroom. For a visually impaired student to function optimally in the world of science, certain modifications in equipment, strategies, and/or presentation are necessary.

This section contains some general considerations, recommendations, and strategies for visually impaired students. They are mainly selected and paraphrased from the report, The College Student with a Disability: A Faculty Handbook, published by the President's Commission on the Employment of the Handicapped. It must be remembered, however, that due to the different degrees and kinds of legal blindness, these strategies must be applied on an individual basis. Even though there is a small degree of overlap, the various types of visual impairments are grouped for the purposes of this discussion, according to how the student functions: 1) those with sufficient vision to read print, 2) those who use tactile skills to acquire information, and 3) those who cannot use sight or tactile skills, but only use auditory stimuli (Ricker, 1981b).

General Considerations for the Totally Blind Student

The major challenge facing totally blind students in the classroom is the overwhelming mass of visual material with which they are continually confronted in textbooks, class outlines, class schedules, bibliographies, tests, writing on chalk-boards, etc. In addition, the increasing use of films, videotapes, overhead projectors, and closed-circuit television adds to the volume of visual material to which they have no access.

Blind students (unless recently blinded) have probably developed various methods for partially dealing with the volume of visual materials. Most blind students use a combination of methods including human readers, brailled books, audio tapes, recorded books, and lectures.

Students may also need ***raised line drawings*** of diagrams, charts, and illustrations; ***relief maps;*** and ***three dimensional models*** of physical organs, shapes, microscopic organisms; etc. Modern technology has made available other aids for blind students, including ***talking calculators, braille clocks, braille wrist watches, speech-time compressors, paperless braille machines, talking terminals,*** and ***braille computer terminals. Reading machines*** have been developed recently which are usually located in some regional resource centers and large libraries. Gradually, they are becoming more available for general student use.

Many blind students who use braille prefer to take their own notes in class using a slate and stylus or braille writers like the ***Perkins braille-writer*** or an ***electric braille-writer.*** Some students ask a classmate to make a copy of their notes using carbon paper, ***carbonless copy paper,*** or a copy machine; the blind student's reader later reads the notes onto tape. Some blind students tape record lectures and later transcribe important segments of the lectures into braille.

The instructor should remember that "this and that" phrases are meaningless to the blind student (for example, "the sum of this plus that equals this" or "the lungs are located here and the diaphragm here"). In the first example, the instructor may be writing on the chalk board, and can just as easily say, "The sum of 4 plus 7 equals 11." The blind student in this case is getting the same information as a sighted student. In the second example, the instructor may be pointing to a model or to the body itself. In this instance, the professor can "personalize" the locations of the lungs and diaphragm by asking class members to locate them by touching their own bodies. Non-visual teaching of this type will not always be possible. But if the instructor does not rely exclusively on visual examples, the blind student as well as the rest of the class will surely benefit.

Some faculty members are concerned about having their lectures recorded by blind or by sighted students. When an instructor is planning to publish his lectures, he may fear that such tapes will somehow interfere with these plans. If this is the case, the faculty member may ask the student to sign an agreement not to release the recording or otherwise hinder the instructor's ability to obtain a copyright.

Instructors having blind students can be very helpful by choosing class texts early. It takes several months to have a text auditorially recorded or brailled. If texts are selected early, the instructor should make this information readily available through the appropriate administrative channels, so that brailling (or recording) can be done or an existing braille text can be acquired.

Some blind students use ***guide dogs.*** There is no need to worry that these highly trained and disciplined dogs will disturb the class. Most of the time the dog will lie quietly under or beside the table or desk (be sure it is out of the traffic pattern, especially in laboratories). The greatest disruption an instructor can expect is an occasional yawn or stretch. It is good to remember that, as tempting as it may be to pet the dog, the guide dog while in harness is responsible for guiding the owner who cannot see. The guide dog should not be petted or otherwise distracted from this duty.

If classes include field trips to out-of-class locations, the instructor should discuss traveling needs with the blind student. In most instances all that will be required is for a member of the class to act as a ***sighted guide.*** In localities where public transportation is adequate for class travel, many blind persons will need little or no assistance since many of them travel independently.

General Considerations for the Partially Sighted Person

Approximately 80 percent of all legally blind individuals in the United States have measurable vision. The partially sighted student meets the challenge of disability in much the same way as the totally blind student. This includes the use of readers, audio-taped texts, raised line drawings, etc. In addition, the partially sighted student may be able to use ***large print books, a closed-circuit television magnifier,*** or other such devices. The student may also use a ***large print typewriter*** for papers. Some partially sighted students will be able to take notes in class by printing very large letters with a felt-tip pen or marker. Others will want to tape record lectures for later use.

There are several basic difficulties that the partially sighted student is confronted with that the totally blind student is not. First, the partially sighted student is sometimes viewed by instructors and classmates as "faking it." Since most partially sighted students do not generally use white canes for travel and are able to get around much like everyone else, people have difficulty believing that the student needs to use adaptive methods when utilizing printed materials.

One partially sighted student commented that after having been observed playing Frisbee by one of her instructors, she was sure he would no longer believe that she was visually impaired. As she explained, she had more peripheral than central vision and could see a red Frisbee. If any other color Frisbee had been used, she could not have seen it well enough to play. Playing Frisbee and reading a printed page present quite different visual requirements. This is often difficult for a fully sighted person to understand.

A further difficulty that the partially sighted student has is the psychological response that large print evokes from the sighted reader. Such handwritten communications tend to give the reader the idea that "a child has written this." Needless to say, this impression may lead to the conclusion that a student with this kind of handwriting is immature or childish and that the written communication is, therefore, less than sophisticated. Even when the student uses a large print typewriter, this psychological response can still be a problem. In addition, the assumption sometimes is made that the student is merely trying to make an assignment appear longer, as in the case of a term paper of a required length.

Another special problem faced by partially sighted students is their reluctance to use certain aids because they feel that doing so would draw attention to them and thus magnify the differences between the partially sighted and their peers. To illustrate: most partially sighted students will not use a cane for mobility purposes, even though they can benefit considerably from its use. Totally blind students have no such qualms, since it is already obvious that they are blind.

Most of these potential difficulties can be alleviated if the student and the instructor discuss the student's needs prior to the first day of class. Sitting in the front of the room and the instructor's use of large print on an overhead projector may be the only strategies required to assist certain partially sighted students. However, the capacity to read printed materials depends so greatly on conditions such as the degrees of contrast, brightness, and color that it is essential that the student and instructor discuss what methods or devices might be used to maximum advantage. If the teacher discovers that a partially sighted student has not had an evaluation at a low-vision clinic, it may be appropriate to refer the student to this service. A list of low-vision clinics for all fifty states is available from the American Foundation For The Blind, 15 West 16th Street, New York, NY 10011.

General Recommendations for Instructors

What else can instructors do to facilitate the education of a blind student? A few general recommendations follow:

- Talk to the visually impaired student directly and not to a third party. Remember that the student is visually handicapped, not aurally handicapped and is quite capable of hearing and answering for himself.
- Look at the blind student when speaking. Visually handicapped students can derive information from the direction of the voice. Teachers look at sighted students when talking to them to gain eye contact. It is just as important to have direct aural contact with a visually handicapped student.
- Use everyday words like "look" and "see," since they are part of the visually handicapped student's vocabulary. Visually handicapped students "watch" television or "look" at new clothes.

- Announce your arrival or departure. It is easy to say "hello" when you enter a classroom or "goodbye" when you leave. These simple statements let the visually handicapped student know of the instructor's presence.
- Use his name when addressing the student. In the sighted world, a nod of the head to someone who raises his hand may be just as effective as calling him by name. Unfortunately, a visually handicapped student will probably not see the nod of a head, so calling the student by name is the most appropriate way of letting him know that the teacher is calling on him.
- Use simple adaptive procedures on materials and/or equipment so visually impaired students have hands-on experiences. Many times ordinary things can be adapted for the visually impaired without much difficulty. For example: cut notches in a meter stick; remove the crystal of a stopwatch; put large print and braille writing (using dymo-tape and a braille labeler) where conventional written materials are used; put directions on how to dissect a frog on a cassette tape so the student's hands will be free to do the dissection; or write directions according to what the student will feel, not in regard to what he sees.
- Use *tactile models* to show visually impaired students what you show sighted students visually. These models may be commercially purchased and modified slightly or they may be home-made. Some examples of models can be found in Ricker (1980) and Ricker and Rodgers (1981).
- Use a script to go along with tactile models and/or tactile examinations. It is generally best to record the script on cassette tape so the student's hands remain unoccupied. An effective script for the visually impaired is made in the following manner (Ricker, 1981c):

1) Start the description from the outside of the model and go towards the inside. After all, the first thing the student touches will be the outside.

2) Describe locations in terms of the face of a clock. This technique can also be used to describe the classroom and laboratory.

3) When you name the object, allow enough time for the student to locate it on the model before you describe it. Otherwise, he may still be trying to find it and not get any information from your description.

4) After everything is examined, finish with a summary so that the student is free to listen without worrying about examining the model at the same time.

- Raised-line drawings are invaluable to blind students and can be easily and economically prepared by writing with a blunt pencil or ball-point pen on polyethylene sheeting, aluminum foil, manilla folders, plastic report covers or discarded overhead transparencies (Ricker, 1980). Another simple method utilizes Elmer's (or similar) glue. By cutting a small opening at the top of the bottle and using it as a marker, you get a permanent raised-line drawing. Before the glue dries, you can sprinkle powders such as sand and cork on it, which will add texture to the raised lines. The glue method is ideal for graphs and line diagrams.
- Use cut-and-paste diagrams. These diagrams take longer to make than other types, but more information can be shown on them. To construct a diagram, various materials (fabric, sandpaper, string, pipe cleaners, buttons) are cut and glued to a sturdy paper (e.g., manila folders). A cell membrane can be made from twine, the nucleus from fabric, the cytoplasm from sandpaper, and the vacuoles can be represented as holes cut in the sandpaper. To produce a diagram of an animal cell costs less than 20 cents (Ricker, 1980).
- Use the well-developed sensory skills of the visually impaired student to teach sighted students who very often may not notice *tactile, auditory,* or *olfactory stimuli,* as in the following example. On a marine biology field trip, two small species of fish were caught. The sighted students were having a difficult time remembering which one was which because of their similarity. A totally blind student had no difficulty at all in correctly identifying a fish when it was presented to him. Finally, one of the sighted students asked him how he could differentiate the fishes. He said it was easy: one was more flat and the other more round.
- Consult the special education unit of the public school system about itinerant teachers, resource teachers, or other educational vision consultants for additional recommendations for the students' educational needs. At the university or college consult the special services unit about these needs.
- Develop a strategy for pre-notification so that the registrar notifies the instructor about a disabled student. Many times disabled students will not tell instructors that they are disabled.
- Ask in advance whether a museum (or other field-visited location) will permit a blind student to tactilely examine certain exhibits, displays, or equipment.
- Watch for signs of visual fatique in partially sighted students when they use their residual vision for long periods of time.
- While in elementary or secondary school, the visually impaired student will probably have someone to arrange for the brailling or recording of printed material. The college student, however, will most likely arrange for obtaining brailled or recorded material himself. Therefore, it is imperative that the college student receive assignments early enough to have the brailling or recording done.
- One very important action to minimize the difficulties of the visually impaired student is the open and frequent communication between the instructor and the student. During these discussions the instructor can ask what the

student can and cannot see, the aids the student has, and the needs the student will have during the course.

- Interaction with the student while engaged in the learning activity, e.g., a laboratory exercise is very helpful. Blind students frequently complain of instructors' "avoidance behavior," especially in the laboratory setting.
- When using a tactile model, line drawing, or other tactile imagery, be sure the scale is clearly explained in terms the student can understand.
- Consider the general learning needs of the visually impaired student. (See Chapter I for a discussion of these needs in relation to all physically handicapped students.) While these needs are common to all learners, special attention should be given to them when a visually handicapped student is in the science class.

The teacher should also recognize that visually impaired students experience desires and frustrations similar to those of non-visually impaired students. However, visually handicapped students may not be able to deal with these desires and frustrations in such usual ways as dating or going for a drive alone to "cool off." Although blind students who were mainstreamed from an early age generally have better relationships with their peers.

It is easy for the teacher to unknowingly allow a double standard to exist in the classroom and to patronize the visually impaired student. The teacher must strive to avoid such situations. On-the-other-hand, some instructors unconsciously require more from a visually impaired student than from his peers—for instance, in an oral examination it is possible to inadvertently phrase higher-level questions in terms of, say, Bloom's Taxonomy than those asked in the written exam. Expect just as much (but not more) from a visually handicapped student as from a sighted one; it is not doing the visually handicapped student a service to give him an easier task or to excuse him from part of the science course. Neither the teacher nor the student should consider the study of science non-essential just because the student cannot see well. Learning about and being involved in science is just as important for the visually handicapped as it is for the sighted. Moreover, a career in science or a science-related field should not be ruled out for visually impaired students. Some totally blind and partially-sighted persons have become physicians, zoologists, geneticists, engineers, technicians, etc.

It is imperative that visually handicapped students have opportunities to experience success in the science classroom, and a major goal of this chapter is to assist in the planning and design of these kinds of instructional programs. Two of the factors discussed on page 3 are of considerable importance to the visually impaired student: 1) that extra cognitive reinforcement may be needed and 2) that there may be a low level of understanding of certain concepts.

The visually impaired student may need extra reinforcement as a direct function of his disability. Sighted students usually have many opportunities to receive reinforcement about the ideas they study in the science class. These students are able to actually see out-of-class applications of the ideas they learn in class, while the student without sufficient vision will not have these same kinds of experiences to reinforce what is studied in the classroom.

The initial level of understanding of specific ideas or concepts for a visually handicapped student may be very low compared to sighted students. The visually handicapped student may lack the background experiences of other students. The instructor may have to use a teaching strategy that moves toward the final teaching objective(s) with more carefully paced learning experiences. Not only do these students have limited visual experiences, they also may have had limited tactile experiences caused by problems of mobility (not being able to travel to the site); accessibilty (things not available); size (either too big or too small to touch); safety (not safe to touch); and fear of breaking things and/or being humiliated.

When visually handicapped students are mainstreamed, the sighted students in the class also benefit. They learn the real meaning of what it is to be visually impaired and that visually impaired people are not a different human species. In this context the instructor should attempt to find ways to help the blind student interact with his peers as equals. Sighted students also learn the falsehood of many widely accepted notions about the blind. Among these is the myth that blind people have a "sixth sense" or special hearing capabilities. Rather, visually impaired students must rely more heavily on their hearing and hence tend to develop—through practice—more "hearing awareness" than do their sighted peers.

General Considerations for Instructors

There are many strategies that are specific to a certain group of visually handicapped students. If a student has sufficient vision to read print, the following factors should be considered (Ricker 1982, personal communication): The amount of light. A student who has retinitis pigmentosa is generally nightblind and his vision in darkness or in a dimly lit classroom is not as effective due to the lack of rods on the retna. This student could be seated near a window or given a desktop study lamp to supplement the lighting in the classroom. He is also likely to have tunnel vision, and so may stumble or trip on things that are in the peripheral field of vision.

On the other hand, some students cannot function in bright light [illegible] the presence of glare. An albino student, for example, cannot see well in bright light since the absence of m[illegible] permits too much light to enter the eye.

Consequently, for this student to function optimally, he needs to be seated away from the windows in a darker portion of the room.

The amount of contrast and the amount of glare. High contrast with a minimum of glare is of great importance to the partially sighted. Thus, for instance, "ditto" pages, which have purple ink on a white page, provide very poor contrast and are especially difficult for a visually handicapped student to read. Black ink on white or cream colored paper provides sharper contrast and results in considerably easier reading for these individuals. White lettering on a dark background (such as we see on interstate road signs) can also be very effective. The texture of paper is also important. A smooth, glossy paper will reflect light and make reading more difficult, while a rougher, non-glossy paper (vellum or matte-finish) will absorb light and be much easier to read.

The distance from the instructional source. Whether the instructional medium is a film, an overhead projector, or a chalkboard, the visually handicapped student must be close enough to see it. (Also, any writing put up for all to see should be neat and legible.) Even if a student can see the writing, it will be useless unless the student can read what he sees. Some students will use monocular or binocular telescopic aids which are either hand-held or clipped to the frame of their glasses. When students use a telescopic aid, their field of vision is reduced.

The amount of time needed to complete assignments. Any student who uses a visual aid that magnifies is generally going to need extra time to complete assignments. Magnification decreases the field of vision and, as a result, visual tasks take longer. Certain partially sighted students with poor central vision will not be able to read as rapidly as other students since they do not have the ability to scan.

The size of print. Some visually handicapped students are able to read regular-size print found in any textbook; others are not able to read regular print. If a student cannot read regular print, there are several mitigative strategies that can be applied in order to facilitate reading:

1) A hand-held magnifer may be used to enlarge the print. Magnifying aids may consist of a simple reading lens that is hand-held (or on a stand) or a special lens system that is attached to the frame of the student's glasses.
2) ***Closed circuit television*** (CCTV) that enlarges print, such as a ***Visualtek*** or ***the Apollo system,*** may be used.
3) Large print textbooks may be used.

If any of these techniques are used, a student may read at a considerably reduced speed.

Assistive Systems Available for a Totally Blind Student. If a student does not have sufficient vision to read print and uses his sense of touch to obtain most of his information, there are certain strategies that need to be considered. Below are several such strategies (Ricker 1981, personal communication):

1) ***Braille.*** Reading and writing braille is not the same as reading and writing print. It is considerably slower and more cumbersome. Braille books are considerably more voluminous; for instance, one print book occupies several volumes in braille. Also, braille books are quite expensive and not every book, magazine, or article is reproduced in braille, so a student who uses braille does not have access to all of those things that a student who utilizes print might have.

Recently, these problems have been alleviated somewhat: a system called ***paperless braille*** or ***cassette braille*** eliminates the space problem to a certain degree. Using this system, several hundred pages of printed material can be stored on a cassette tape. A special tape player converts the electronic impulses to braille characters which can be tactilely read by the visually handicapped student. In addition, ***computer braille*** makes the transcribing of print into braille much quicker than transcribing by hand. Thus, materials in print can be made available in the form of braille much more rapidly than was possible a few years ago.

2) ***Optacon.*** The Optacon is a small device that uses a small camera and an array of pins to convert print into a raised image of letters which can be read tactilely. The camera produces a TV-type image of the letter, which is then reproduced by raising specific pins in a special tactile box. The visually handicapped student can learn to read the letters by placing his fingertip on this array of vibrating pins. A major advantage of this system is that it enables a visually handicapped student to read print material without having to wait until it has been transcribed into braille or recorded on a vocal system. One disadvantage is the high cost of this device.

If a student has neither sufficient vision to read print nor the tactile skills to learn braille, then material must be presented to him aurally. Various ways to accomplish this are described below (Ricker, personal communication).

3) ***Tape recorder.*** Teachers can put material on tape and give the tape to the student, or the student can record information that is important and have a means of reviewing it later. The National Library Service for the Blind and the Physically Handicapped, of the Library of Congress, in Washington, D.C., provides many books and magazines, as well as equipment for the visually handicapped person, free of charge. In addition, The Recordings for the Blind, Inc. lends many recordings of science textbooks, free of charge. Further, they will tape any requested written materials.

4) ***Kurzweil Reading Machine.*** This electronic device actually reads the words of a print book to the visually handicapped student. Once the student learns to operate the machine, he can control the speed and volume and can even direct the machine to spell an unfamiliar word. A disadvantage is the high cost of this device.

5) ***Optacon with Voice Output System.*** The Optacon has a speech synthesizer which can be added to the unit. With the synthesizer, the printed material is converted to sound, and the visually impaired student listens to the words of a book instead of reading it with his fingers. One disadvantage is the high cost of this device.

6) ***Speech Adaptive Equipment.*** A variety of instruments and others devices--for instance, electrical meters, thermometers, calculators, and ***CRT terminals***--can be coupled to speech synthesizers to provide aural readouts to blind students. See page 19, Table 2.

Summary

There are many factors that need to be considered when planning the educational activities of a visually impaired student. Probably the most important are the primary communication modes in which the student functions (viz., print, braille, auditory, or combinations thereof). Once this is determined, the instructor can incorporate the appropriate strategies into his teaching plans. He will then be able to obtain the appropriate materials necessary to minimize the student's disability.

SECTION III. SPECIFIC MITIGATIVE STRATEGIES: THE REFERENCE TABLES

This section is concerned with the specific mitigative strategies for the seven common teaching methods in science. Because of the extremely diverse group of sub-disciplines in science, we believe that we must focus on those aspects of teaching science which are common to all. These seven aspects of teaching are: teacher presentation, laboratory exercises, reading assignments, discussion, audio/visual, research problems, and field trips.

In order to use the following set of two tables, one needs to generally categorize the impairment of the student (viz., partially sighted with some reading skills, totally blind with good tactile skills, or totally blind with poor tactile skills), and to then identify the general teaching method and the specific mitigative strategy. After this identification is completed in Table 1, one then proceeds to Table 2 obtaining the mitigative strategies or techniques referred to in Table 1. If a mitigative strategy is not self-explanatory in Table 2, then for a more detailed description or construction/modification guide, the user is directed to the specific reference, or to the glossary.

In compiling these two tables, it was recognized that the selection of a specific mitigative strategy is very dependent upon the severity of the affliction. Therefore, we present a set of alternative strategies or techniques (when available) so that the instructor can work with the student in selecting the most appropriate strategy.

In Table 1 the teaching methods are followed by the appropriate set of possible mitigative strategies for each visually impaired functional group. These mitigative strategies can be used to neutralize the educational deficiency caused by the handicap. Each type of visually impaired student is assumed to have normal hearing. Group A (partially sighted) refers to those visually impaired students who have sufficient vision to read printed materials. Group B refers to visually impaired students who use tactile modality (e.g., braille, Optacon) as their primary "reading" modes. Group C refers to those individuals who neither read print nor use tactile "reading" modes. Virtually all information for this latter category of students must come from the auditory pathway.

EXAMPLE

If an instructor wanted to know what he needed to do in order to optimize a reading homework assignment for a totally blind student who uses braille, he would refer in Table 1 to the teaching method titled "Reading". He would then locate, under group B, the numbers of the mitigative strategies. He would then go to Table 2 for the specific mitigative strategies. In this case, the referenced strategies are numbers 1.02, 1.08, 2.06, 2.07, 2.10, 2.27, 3.02, 3.06, and 3.07.

The instructor would find the following strategies given:

1.02 Allow more time for the activity
1.08 Make all handouts and assignments available in the appropriate form: print, large print, braille, or cassette.
2.06 Use of Optacon.
2.07 Use of Kurzwiel Reading Machine.
2.10 Use of tape recorder.
2.27 Use of paperless braille.
3.02 Use of a paid or volunteer reader.
3.06 Use of a transcriber to put materials and books into braille.
3.07 Use of someone to record books and materials on a cassette recorder.

The instructor could use all or only some of these strategies to assist the visually impaired student in the completion of his reading assignment.

TABLE 1. INSTRUCTIONAL METHODS AND POSSIBLE MITIGATIVE TEACHING STRATEGIES (MTS) FOR STUDENTS WHO ARE:
A = PARTIALLY SIGHTED WITH SOME READING SKILLS.
B = TOTALLY BLIND WITH GOOD TACTILE SKILLS.
C = TOTALLY BLIND WITH POOR TACTILE SKILLS.

TEACHING METHOD: TEACHER PRESENTATION (Lecture)[1]	
MTS: A.	1.06, 1.08, 1.16, 1.22, 1.23, 1.24, 1.25, 1.28, 1.29, 2.10, 2.30, 3.03, 3.04, 3.08
B.	1.06, 1.08, 1.16, 1.17, 1.20, 1.21, 1.22, 1.23, 1.24, 1.25, 1.28, 2.09, 2.10, 2.24, 2.25, 3.02, 3.03, 3.04, 3.07
C.	SAME AS B (SOME MAY NOT WORK, HOWEVER)
TEACHING METHOD: ACTIVE AND PASSIVE LABORATORIES[2]	
MTS: A.	1.01, 1.02, 1.03, 1.04, 1.05, 1.06, 1.07, 1.08, 1.09, 1.10, 1.11, 1.12, 1.13, 1.14, 1.18, 1.19, 1.22, 1.23, 1.24, 1.25, 1.26, 1.28, 1.29, 2.01, 2.04, 2.08, 2.10, 2.21, 2.23, 2.24, 2.25, 2.29, 2.30, 2.31, 2.35, 3.01, 3.03, 3.04
B.	1.01, 1.02, 1.03, 1.04, 1.06, 1.07, 1.08, 1.09, 1.10, 1.11, 1.12, 1.13, 1.14, 1.15, 1.18, 1.19, 1.20, 1.22, 1.23, 1.24, 1.25, 1.26, 1.28, 1.31, 1.33, 2.01, 2.02, 2.03, 2.04, 2.08, 2.09, 2.10, 2.19, 2.20, 2.21, 2.22, 2.23, 2.24, 2.25, 2.29, 2.32, 2.33, 2.34, 2.40, 3.01, 3.03, 3.04
C.	SAME AS B (SOME MAY NOT WORK, HOWEVER)
TEACHING METHOD: READING	
MTS: A.	1.02, 1.08, 1.28, 1.29, 1.32, 2.05, 2.31, 3.02, 3.08
B.	1.02, 1.08, 2.18, 1.30, 2.06, 2.07, 2.10, 2.27, 2.28, 3.02, 3.06, 3.07
C.	1.02, 1.08, 1.23, 1.28, 2.07, 2.10, 2.28, 3.02, 3.07
TEACHING METHOD: GROUP INTERACTION AND DISCUSSION	
MTS: A.	1.06, 1.23, 1.29, 2.10, 3.03
B.	1.06, 1.23, 2.10, 3.03
C.	1.06, 1.23, 2.10, 3.03
TEACHING METHOD: A/V TACTILE[3]	
MTS: A.	1.02, 1.16, 1.17, 1.18, 1.21, 1.22, 1.25, 1.26, 1.29, 2.11, 2.12, 2.13, 2.14, 2.15, 2.16, 2.17, 2.18, 2.24, 2.25, 2.30
B.	1.02, 1.14, 1.16, 1.17, 1.18, 1.21, 1.22, 1.23, 1.25, 1.26, 2.10, 2.24, 2.25
C.	SAME AS B (SOME MAY NOT WORK, HOWEVER)
TEACHING METHOD: RESEARCH PROBLEM[4]	
MTS: A.	1.02, 1.29, 1.32, 2.05, 2.08, 2.10, 2.26, 2.30, 2.35, 3.02
B.	1.02, 1.30, 1.33, 2.08, 2.10, 2.26, 2.40, 3.02
C.	SAME AS B (SOME MAY NOT WORK, HOWEVER
TEACHING METHOD: ACTIVE AND PASSIVE FIELD TRIPS[2]	
MTS: A.	1.01, 1.02, 1.03, 1.04, 1.05, 1.06, 1.07, 1.08, 1.09, 1.10, 1.11, 1.12, 1.13, 1.14, 1.15, 1.19, 1.20, 1.22, 1.23, 1.24, 1.27, 1.29, 2.02, 2.04, 2.08, 2.10, 2.19, 2.20, 2.21, 2.22, 2.23, 2.24, 2.25, 2.26, 2.30, 2.34, 2.35, 3.01, 3.03, 3.04, 3.04
B.	SAME AS A (plus 2.36, 2.37, 2.38) (see reading teaching method, if reading is necessary)
C.	GENERALLY THE SAME AS A (plus 2.36, 2.37, 2.38) (see reading teaching method, if reading is necessary)

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[1] This is assuming that there will be little or no discussion. If discussion and questions are used, refer to the section on group interaction.

[2] Reading MTS may apply here for review purposes; also some group interaction MTS may apply here.

[3] This teaching method may be used to supplement other teaching methods.

[4] The research problem may also include strategies from all other teaching methods.

TABLE 2. MITIGATIVE STRATEGIES FOR VISUALLY IMPAIRED STUDENTS

1.0 TEACHING PRESENTATION STRATEGIES

1.01 Keep materials, supplies, and equipment in the same place whether it is on a laboratory table or in a field kit.
1.02 Allow more time for activity.
1.03 Label materials, supplies, and equipment with regular print, large print, or braille.
1.04 Use distinctively shaped containers for toxic materials.
1.05 Use color-coded containers for hazardous chemicals or materials.
1.06 Describe and tactually/spatially familarize the student to the classroom and laboratory.
1.07 Describe and tactually/spatially familarize the student to all equipment.
1.08 Make all handouts and assignments available in an appropriate form: regular print, large print, braille, or cassette.
1.09 Use electrical devices for heating instead of flames.
1.10 When use of flammable devices is necessary, give extra instruction on proper methods.
1.11 Provide means for the recording of data in the appropriate mode.
1.12 Have the student do a trial run before the activity.
1.13 Enforce safety rules rigidly since the visually impaired student is more apt to work closer to the activity and laboratory table.
1.14 Describe in detail all visual occurrences.
1.15 Use simple adaptive procedures on equipment (see page 13; also see Ricker and Rodgers, 1981).
1.16 Use tactile models to show visually impaired students what you visually show non-impaired students (see page 13; also see Ricker, 1980).
1.17 Use a thermoform machine to make multiple, reproduceable tactile diagrams (Ricker and Benifield, 1981; also see sample thermoform last page of this book).
1.18 Use an activity script to go along with tactile models and/or examinations (see page 13; Ricker, 1981b).
1.19 Convert color change indicators in chemistry laboratories to tactile indicators by filtering the precipitate and having the student touch the precipitate on filter paper (Tombaugh, 1981).
1.20 Use a large noteboard for the student to arrange his braille notes on. It can be made by cutting a ½-inch sheet of plywood 4' by 2'.
1.21 Use special techniques when designing or adapting models for the visually impaired (see page 13).
1.22 Place the student closer to the activity for tactile examination and/or recording.
1.23 Place the student and/or recorder an appropriate distance from the activity to permit recording of material.
1.24 Give extra oral description instead of using phrases like "this goes over here."
1.25 Use a sighted narrator to describe movies, filmstrips, filmloops, and slides.
1.26 Modify instructions for auditory/tactile presentation.
1.27 Make arrangements for tactile examination if touch is not normally permitted (i.e. with a museum curator).
1.28 Present examinations in a form that will be unbiased to visually impaired students.
1.29 Be sure student is seated where lighting conditions are appropriate.
1.30 Use braille text.
1.31 Use braille maps.
1.32 Use acetate placed over a printed page to darken print and heighten contrast.
1.33 Use Nemeth Code of braille mathematics and scientific notation.

2.0 MECHANICAL DEVICES

2.01 Provide portable safety equipment that can be taken to the visually impaired student (i.e. eyewash, water for shower, etc.)

2.02 Use an *acoustic compass.*
2.03 Use a *Braille stopwatch.*
2.04 Use a *talking calculator.*
2.05 Use a *Visualtek* or *Apollo system*
2.06 Use an *Optacon.*
2.07 Use a *Kurzweil Reading Machine.*
2.08 Use *graphing board.*
2.09 Use a *Sewell Raised Line Drawing Kit.*
2.10 Use a tape recorder.
2.11 Use an overhead projector.
2.12 Use an opaque projector (which can also be used with Polaroid snapshots).
2.13 Use a microprojector.
2.14 Use a microscope viewer.
2.15 Use a reverse opaque screen for slide projection (Ricker, 1981a).
2.16 Use a rear-view screen projector for general media projection (Ricker, 1981a).
2.17 Use a filmstrip preview (small hand-held viewer that gives some magnification).
2.18 Use a slide previewer (small hand-held viewer that gives some magnification).
2.19 For measuring mass, use an analytical balance (auditory) or Light Sensor in conjunction with an *Ohaus-Cent-O-Gram* Balance (Ricker and Benefield, 1981).
2.20 For measuring liquids, use a syringe with wire attachment, syringe with dowel-rod attachment (Ricker and Benefield, 1981), squeeze-type dispensors (e.g., *pro-pipette, re-pipette, re-pipette jr.,* or *Audicator).*
2.21 For measuring length, use a braille ruler, braille meter stick, notched meter stick, or painted meter stick.
2.22 Use an *Aud-a-mometer.*
2.23 Use a *Voice Synthesizer Thermometer.*
2.24 Use raised-line drawings and/or diagrams (see page 13).
2.25 Use a cut-and-paste model (see page 13).
2.26 Use a typewriter.
2.27 Use *Paperless Braille* (sometimes referred to as "Versa Braille").
2.28 Use *Compressed Speech.*
2.29 Use an auditory or tactile signal where visual signal exists.
2.30 Use optical low-vision aids.
2.31 Use a microslide viewer.
2.32 Use a light sensor.
2.33 Use *Braille slide rule* or protractor.
2.34 Use a *Raised-dot barometer,* thermometer, or directional compass.
2.35 Use magnifiers.
2.36 Use a *Pathsounder.*
2.37 Use a *Laser Cane.*
2.38 Use a *Sonicguide.*
2.39 Use *Bioptic systems.*
2.40 Use a *Braille Terminal/Printer System.*

3.0 OTHER STRATEGIES AND ASSISTANCE FROM OTHER PEOPLE

3.01 Use a non-dominant laboratory partner.
3.02 Use a reader (either paid or voluntary).
3.03 Use a notetaker who takes notes in the appropriate mode.
3.04 Make teacher's notes available to the student. The notes could be placed on reserve in the library (in typed and tape form, for instance).
3.05 Use a sighted guide.
3.06 Use a person to translate books and materials into braille.
3.07 Use someone to record books and materials on a recorder.
3.08 Convert books and materials into large print.

CHAPTER III

THE HEARING IMPAIRED

SECTION I. THE NATURE OF AND THE GENERAL CAUSES OF HEARING IMPAIRMENT

Hearing is the sense by which sounds are perceived. In the process of hearing, the ear converts physical sound waves into nerve impulses. The impulses travel to the brain where they are interpreted as sounds. Hearing impairment results from a dysfunction of the ear or of the auditory nerve (Newby, 1972).

The Anatomy of the Ear

The anatomy of the ear is illustrated in Figure 2. The following description is paraphrased from the Encyclopedia Americana, International Edition, 1978 (Volume 9).

The three major parts of the ear are: (1) the outer ear, (2) the middle ear, and (3) the inner ear. The outer ear has two basic structures, the outer appendage, or **auricle,** formed from cartilage and covered with skin, and the **auditory canal** which leads to the middle ear. Sound waves enter the outer ear and travel through the auditory canal to the **eardrum,** or **tympanic membrane,** a thin membrane that stretches across the end of the auditory canal. The tympanic membrane marks the boundary between the outer ear and the middle ear.

Within the middle ear are the **ossicles**—three small bones called the **malleus,** the **incus,** and the **stapes.** These bones transmit vibrations across the middle ear. The **oval window** is a membrane that separates the **vestibular mechanism** of the fluid-filled inner ear from the air-filled middle ear. The middle ear cavity connects to the *pharynx* via the **eustachian tube.**

The inner ear consists of a system of canals known as the **membranous labyrinth.** It has three structures, the **semicircular canals,** the **cochlea,** and two sacks called the **utricle** and the **saccule.** Within the cochlea are sensory cells upon which fibers of the **auditory nerve** end (Figure 2). The **organ of Corti,** which lies within the cochlea, is the organ responsible for sending the nerve impulses to the *cerebral cortex* where they are interpreted as sound.

Definitions

A variety of terms are used to describe sound, hearing, and hearing impairments. Sound intensity, or volume, is measured in *decibels* (dB). Figure 3 shows the sound intensities of some familiar sounds. The threshold of hearing is the lowest sound intensity level at which one can perceive sound. Normal thresholds of hearing range from 1 to 15 dB.

Within the fields of special education and deaf education, **deaf individuals** are usually distinguished from **hard-of-hearing people.** In 1973, a committee of the Conference of Executives of American Schools for the Deaf defined the terms "deaf" and "hard of hearing" as follows (Frisina, 1974): A deaf person is one whose hearing is disabled to an extent that precludes the understanding of speech through the ear alone, with or without the use of a hearing aid. In quantitative terms, a deaf person cannot hear the sounds of intensities up to 70 decibels. A hard of hearing person is one whose hearing is disabled to an extent that makes difficult, but does not preclude, the understanding of speech through the ear alone, with or without a hearing aid.

Both [illegible] and hard-of-hearing individuals are divided into two groups depending on the age at which their hearing loss occurred. The first group consists of the **congenitally hearing impaired,** those who were born with hearing loss. The second group consists of those who were born with normal hearing and later sustained a hearing loss through illness or accident. This is called an **adventitious,** or **acquired, impairment.**

Hearing impairments that occur before the acquisition of language can cause difficulties in language development. This condition is referred to as prelingual deafness.

Audiologists have developed the following five categories of hearing impairment: **conductive hearing impairment, sensori-neural hearing impairment, mixed impairment, central hearing impairment,** and **psychogenic impairment.** These are discussed below. As shown on Table 3, each category of impairment has its own area of involvement and characteristic range of hearing loss.

Descriptions of Hearing Impairments

Here we discuss each of the five categories of impairment and the major hearing disorders of each category. The categories of central hearing impairment and psychogenic impairment are the least common of the five and will be given less attention in this book.

FIGURE 2. THE ANATOMY OF THE EAR.

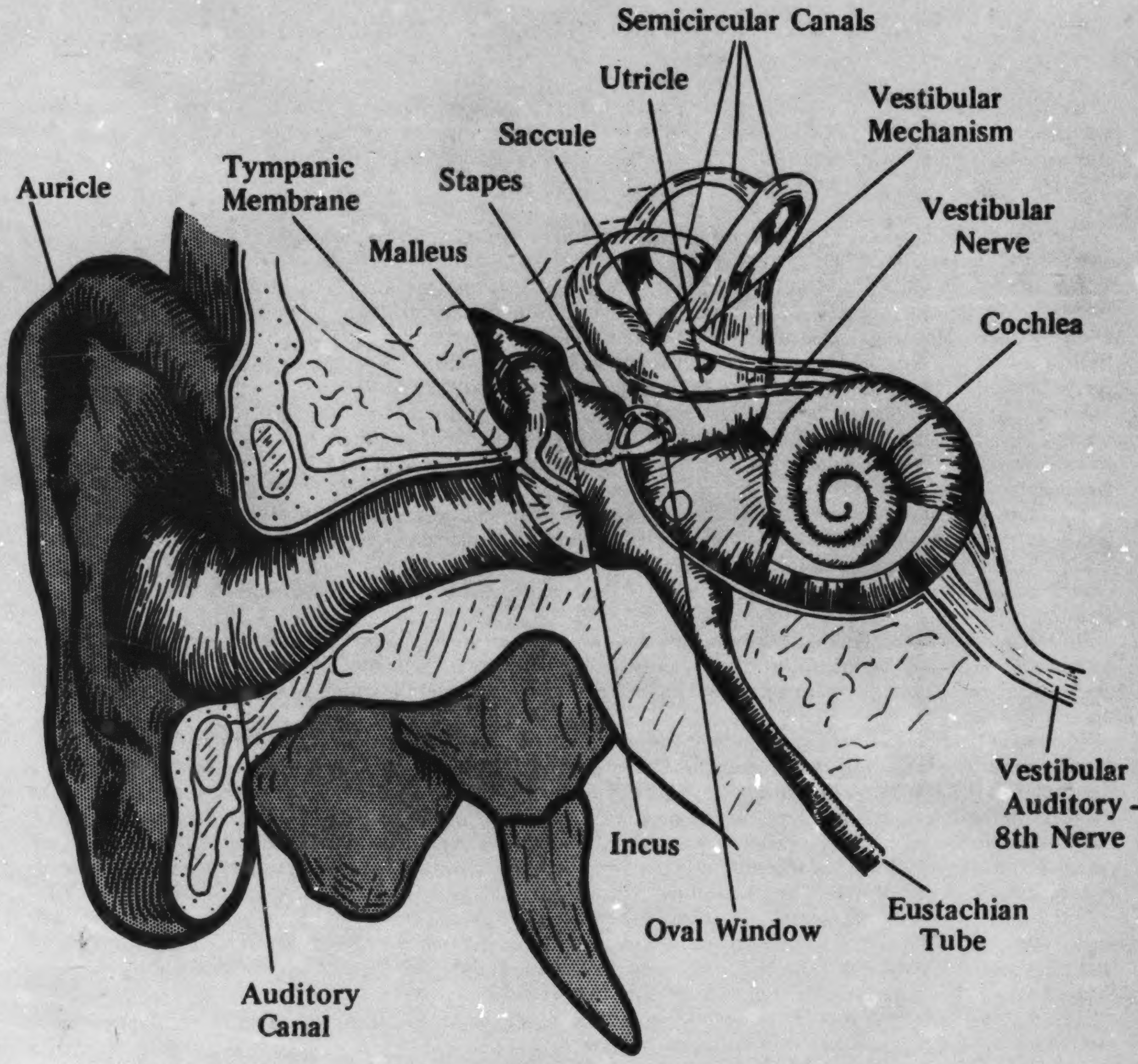
Semicircular Canals
Utricle
Vestibular Mechanism
Saccule
Auricle
Tympanic Membrane
Stapes
Vestibular Nerve
Malleus
Cochlea
Vestibular Auditory - 8th Nerve
Incus
Eustachian Tube
Oval Window
Auditory Canal

FIGURE 3. APPROXIMATE DECIBEL LEVELS OF VARIOUS SOUNDS

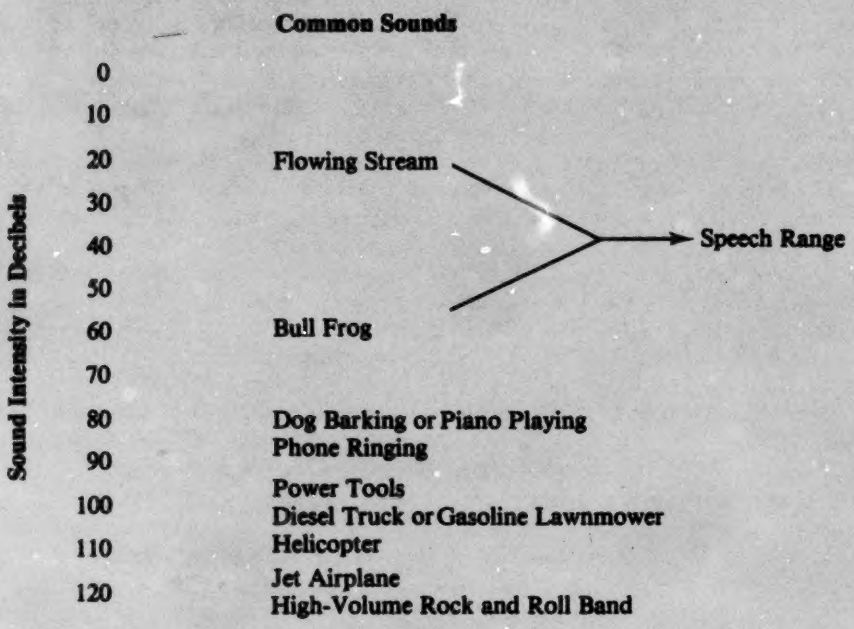

TABLE 3. CATEGORIES OF HEARING IMPAIRMENT, AREAS OF INVOLVEMENT, AND DEGREE OF HEARING LOSS.

Category of Hearing Impairment	Area of Involvement (site of auditory disorder)	Degree of Hearing Loss
A. Conductive Hearing Impairment	Outer and Middle Ear Dysfunction	Mild to Moderate
B. Sensori-neural Hearing Impairment	Inner Ear and Auditory Nerve Dysfunction	Mild to Profound to Non-functional (Deaf)
C. Mixed Impairment	Both Conductive and Sensorineural Dysfunction	Mild to Profound to Non-functional (Deaf)
D. Central Hearing Impairment	Neurological Dysfunction (Brain level Involvement)	Not applicable
E. Psychogenic Hearing Impairment	Psychological Dysfunction (Mental disorder)	Not applicable

A. Conductive Hearing Impairment. Conductive hearing impairment is the interruption of the mechanical transmission of sound within the outer or middle ear areas. Individuals with conductive hearing loss have thresholds of hearing considerably higher than those of people with normal hearing. Conductive hearing impairments generally result in a hearing loss of up to 70 dB. Most people with conductive hearing impairment have a flat decibel loss, which means they have the same degree of impaired hearing across a range of frequencies (low-pitched tones to high-pitched tones). People with conductive hearing impairment may experience a ringing in the ears or head called tinnitus.

Most conductive hearing losses can be improved by medical intervention. Using a hearing aid, many individuals can hear both speech and environmental sounds. But whether or not they use a hearing aid, people with conductive hearing impairments are often able to make use of their residual hearing by adjusting the acoustic conditions around them—for instance, turning up the volume on a television or stereo.

Individuals with conductive hearing impairment are able to monitor their own voice level because they are able to perceive their own voice through their mastoid bones (the porous bones behind the ears). The ability to monitor one's own voice level helps a person function appropriately in social situations.

The following conditions most often cause conductive hearing impairments.

1. Outer Ear Conditions

Congenital Atresia is a condition caused by a missing auricle or a deformed auricle that partially or completely covers the outer ear canal.

Cerumen Blockage is a condition caused by an excessive build-up of cerumen (ear wax). Cerumen normally functions as a protective coating over the ear canal.

2. Middle Ear Conditions

Otitis Media is a condition caused by an infection which invades the middle ear. In its milder forms it is known as an "ear ache." This condition, however, can cause mild to severe hearing loss and is the most common cause of conductive hearing impairments (Newby, 1972). The infection can restrict the movement of the ossicles, thus impeding sound transmission. Pus-filled fluid may also cause adhesions and growths to form around the ossicles, and if not treated, can result in further damage. In some cases, otitis media may invade the cochlea of the inner ear. Chronic otitis, a situation in which an individual is especially subject to this disease, is difficult to correct and may require surgery.

Retraction of the Tympanic Membrane is a condition caused by a blockage in the eustachian tube. This blockage affects the ability of the middle ear to equalize pressure. Outward pressure can therefore force the tympanic membrane inward and possibly rupture it.

Otosclerosis is a condition caused by the progression of otitis media beyond the stapes of the middle ear, through the oval window and into the cochlea, turning the cochlea soft and spongy. The fixation of the stapes will also reduce sound transmission. Otosclerosis is generally a disease of early adulthood.

B. Sensori-Neural Impairment. Sensori-Neural Impairment is the interruption or impediment of sound transmission within the inner ear and/or the auditory nerve pathway, causing a distorted or partial production of electrical impulses to the brain. It involves the neural transmission of sound impulses. This type of impairment involves both volume and clarity.

A sensori-neural impairment may result in a loss in ablilty to discriminate between varying sounds—that is, a loss of clarity rather than volume. Sensori-neural impairment can occur at different frequencies, as well as at different intensities. Typically, an individual will perceive low-frequency sounds better than high-frequency sounds. Some individuals will have difficulty discriminating among speech sounds, regardless of the volume and therefore might not benefit greatly from amplification. Because individuals with a sensori-neural impairment may not be able to discriminate frequency or intensity, they may also have tone and pitch distortion of their voice and difficulty with voice volume control. In addition, they often experience the sensation of ringing (tinnitus) in either ear or in the head. Some individuals may also demonstrate a negative reaction to loud sounds due to the disproportionate increase of intensity above their threshold of hearing.

There are congenital, genetic and acquired causes of sensori-neural deafness. The congenital conditions can be divided into two categories: those where hearing loss is the only problem, and those where hearing loss is one of many, possibly related, problems. There are about 17 congenital forms of deafness that follow a simple, predictable inheritance pattern, and 30 or so forms which do not appear to follow a regular inheritance pattern (McKusick, 1978). In addition, perhaps as many as 80 genetic, or partly genetic, conditions exist where hearing loss plays some role in the disability (McKusick, 1978). These conditions might involve a very mild impairment or a low risk of impairment, or else the impairment is of a minor nature compared to other overwhelming health problems. Prenatal hearing problems can be caused by environmental factors such as viruses, injury, drugs, alcohol, disease, and allergies. Acquired sensori-neural impairments are caused by such infections as diptheria, measles (rubella), mumps, scarlet fever, whooping cough, meningitis, and influenza.

Several conditions occur within the inner ear which results in sensori-neural hearing impairments. Some of these conditions are described below:

Meniere's Syndrome is a condition which affects the cochlea and vestibular mechanism. Three symptoms identified with Meniere's are: (1) tinnitus (in this case, the ringing may be as loud as a telephone), (2) vertigo (dizziness), and (3) a similar degree of hearing loss in both ears. Generally, Meniere's Syndrome affects white females under the age of 40. This condition is due to an imbalance of pressure in the cochlear fluid.

Acoustic Trauma is a condition which results from an exposure to a single intense noise, such as a blast or explosion, which causes damage to the cochlea.

Noise-Induced Deafness or Hearing Loss is a condition, more common than acoustic trauma, caused by a long-term exposure to intense noise/sound levels.

Presbycusis is a condition caused by the aging process (or by years of exposure to environmental noise). It affects the organ of corti in the cochlea.

Tumors are growths upon the auditory nerve and can cause sensori-neural impairments of varying degrees.

Nerve Damage can result from a severe blow to the head incurred in any number of ways and can cause partial to complete hearing loss in one or both ears.

Figure 4 shows the frequency (in *Hertz*) and decibel levels of the general speech range and the degree of impairment (for both conductive and sensori-neural impairments) represented by increasing levels of decibel loss. More detailed information regarding conductive and sensori-neural hearing impairments is given on Table 4.

FIGURE 4. FREQUENCY AND dB LEVELS OF THE GENERAL SPEECH RANGE AND THE CATEGORIES OF HEARING IMPAIRMENT.

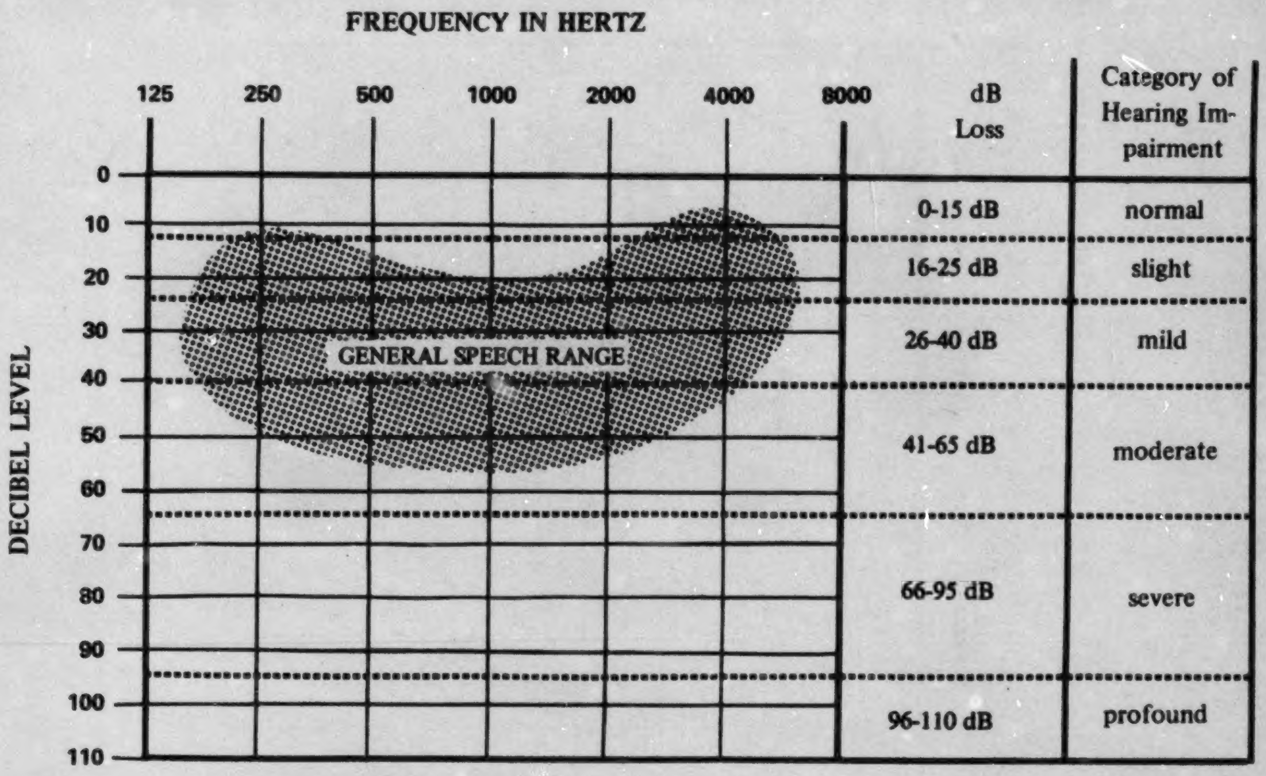

TABLE 4. CHARACTERISTICS OF CONDUCTIVE HEARING IMPAIRMENT AND SENSORI-NEURAL IMPAIRMENT.[1]

TYPE OF IMPAIRMENT	DEGREE OF IMPAIRMENT	DESCRIPTION OF AUDITORY DYSFUNCTIONS	GENERAL DESCRIPTION OF TYPICAL BEHAVIORS	LANGUAGE FUNCTIONING
Conductive Hearing Impairments	mild	Cannot perceive sounds below 26 dB unaided.	Consistent - Good listening behavior. Uses hearing projectively. Gives scanning responses.[2] May ask for repeat of statement, question, answer, etc. Amplification can help.	Varied abilities. Mild to moderate losses. Generally have good inner expressive language abilities. Uses voice projectively. Readily uses gesture and manual language (but not for all degrees of impairment).
	moderate	Cannot perceive sounds below 41 dB unaided.		
	severe[3]	Cannot perceive sounds below 66 dB unaided.		
	profound[3]	Cannot perceive sounds below 96 dB unaided.		
	non-functional[3]	Cannot perceive sounds.		
Sensori-neural Hearing Impairments	mild	May not perceive high frequency environmental and speech sounds p, h, g, ch, sh, k, s, th and t	Consistently straining to understand auditory stimuli when the loss is mild through severe. Sometimes difficulty is demonstrated by giving attention to different voices and sounds. Gives scanning responses.[2] Individual has increased voice levels. Amplification can help but to differing degrees.	Mental processes may be more symbolic and less based on language.
	moderate	May not perceive environmental sounds to 60 dB range as well as speech sounds z, v, j, m, d, b, i, n, o, a, r, ng, e, l, and y		
	severe	May not perceive any speech sounds as well as many environmental sounds in high frequency ranges		
	profound	May not perceive any speech sounds or most environmental sounds except for intense low frequency sounds		
	non-functional	Cannot perceive sounds		

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[1] After Newby, 1972; Brill, 1974; Myklebust, 1954.

[2] Scanning responses - Students give non-specific responses on the basis of partial information drawn from conversation using residual hearing and lipreading. Example: Teacher asks: "What is Newton's First Law of Thermodynamics, and the Student responds: "Yes".

[3] As mentioned earlier, conductive hearing impairment rarely causes hearing loss above about 70 dB.

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C. Mixed Impairment. Mixed impairment consists of the interruption and impediment of sound transmission by both the conductive and sensori-neural avenues. Its characteristics are often those of both conductive and sensori-neural hearing impairments. An example of mixed impairment is an individual who initially has a conductive hearing impairment and who, as he ages, developes presbycusis, a sensori-neural hearing impairment.

D. Central Hearing Impairment. Central hearing impairment is a brain-level disorder which interferes with the proper processing and interpretation of sound stimuli. The ears are anatomically functional, but the brain does not accurately interpret sound. The location of this problem may be anywhere from the brain stem to the ***temporal lobes*** of the ***cerebral cortex***, and formally speaking, central hearing impairment is not an auditory problem. Because it is a brain-level disorder, central hearing impairment is generally more difficult for the audiologist to diagnose (Myklebust, 1954). The following are some of the causes of central hearing impairment:

Rh Factor Incompatibilities between a mother and her fetus can cause central hearing impairment due to brain damage.

Auditory agnosia may be caused by an injury to the cerebral cortex at birth or prior to the acquisition of language. It may also be an acquired condition later on. Auditory agnosia results in a problem in recognizing sound, especially environmental sounds.

Aphasia is a condition in which an individual is unable to comprehend speech or properly express himself through speech. It may be caused by brain trauma at birth or shortly thereafter. Recently, aphasia has been considered to be more often acquired than congenital. Also, in its common usage, aphasia refers to a condition resulting after language acquisition. Historically, aphasia has been confused with hearing impairments because an individual with aphasia may not respond to sound or communicate effectively (Myklebust, 1954).

Central deafness (partial or total), along with complete deafness that is not central deafness, and partial hearing loss have their own medical designations, which are given in Table 5.

TABLE 5. FORMS OF HEARING IMPAIRMENT AND THEIR MEDICAL DESIGNATIONS.

Form of Impairment	Medical Designation
Central Deafness (partial or total)	Dyacusis
Partial Hearing Loss	Hypacusis
Complete Deafness (excluding Central Deafness)	Anacusis

E. Psychogenic Hearing Impairment. Psychogenic hearing impairments are not true hearing impairments; they are not caused by defects in the ear apparatus or auditory nerve. Psychogenic hearing impairment is usually caused by emotional stress or shock. Environmental pressure and stress may cause an individual to seek shelter from the world through a hearing impediment; also, a single traumatic event, such as the sudden death of a loved one, may cause an individual to withdraw into a soundless world.

Concluding Comments: The Significance of Hearing Impairment

The implications of having a hearing loss in our society are enormous and far reaching in scope. First, there is the constant problem of not being able to hear, either completely or partially, human voices and environmental sounds. Second, the individual's language development is often affected. To a large extent this depends on the time of the onset of the hearing impairment. Third, speech and voice quality are often affected by the loss of hearing—which, in turn, creates social problems. For these reasons, educational, personal, and social development may all be considerably affected by a hearing impairment. Shames and Wiig (1982) present an excellent review of language and communication development with associated causes and ramifications of hearing impairments.

SECTION II. GENERAL FACILITATIVE STRATEGIES FOR THE HEARING IMPAIRED

Facilitative strategies for the hearing impaired are primarily concerned with various aspects of communication. According to Brown (1979), the average hearing impaired child, compared to normally hearing peers, demonstrates an ever-increasing gap in vocabulary growth, concept formation, and the ability to comprehend and produce complex sentences. Approximately 330,000 to 440,000 students in the United States can be identified as being hearing impaired or 0.6 to 0.8% of the school population (Brown 1979). Of these students, the ratio of hard of hearing to deaf students is 15 to 1.

Because language and speech improvement are seen as the major needs for hearing impaired youths, content areas such as science and mathematics traditionally receive lower instructional priority (Bybee, 1972). A properly designed science program, however, can provide a variety of learning experiences that can enhance the language and cognitive growth of hearing impaired students as well as teaching the scientific material. The mainstreamed hearing impaired student in the science classroom should encounter opportunities not available elsewhere (not even in special education classes) that can help diminish the lag in cognitive growth and therefore encourage a higher level of abstract thinking. Many of these opportunities take the form of hands on (experimental) activities (Egelston and Mercado, 1975). Lang (1979) suggests that the teacher take care not to exclude deaf students from any responsibilities, and involve deaf students in all classroom and laboratory activities. Science educators, moreover, have an inherent advantage over teachers of other content areas because of the positive motivation provided by the subject matter (Egelston and Mercado, 1975). There are, however, only a few science curricula designed specifically to teach hearing impaired students in the mainstream. Therefore, the science teacher must generally adapt existing methods and materials to accommodate the special needs of these students.

The special needs of the hearing impaired student are generally the same as those for students with other types of physical impairments, but recognition of these needs is believed to be especially critical for deaf students. Culhane and Mothersell (1979) have delineated eleven special needs of hearing impaired students mainstreamed in the regular classroom, as listed below:

1) People who understand the meaning of impaired hearing.
2) Opportunities to communicate.
3) Visual access to information.
4) Opportunities for experiential learning.
5) Opportunities for incidental learning.
6) Opportunities to develop self-esteem.
7) Hearing-impaired role models.
8) Multi-level learning opportunities.
9) Academic success.
10) Opportunities for successful social functioning in classroom situations.
11) Recognition as individuals who happen to have an impairment.

Meeting these needs can be a challenge in light of the communication problems of hearing impaired students. The needs of each student must be assessed on an individual basis. The discussion that follows focuses on the special needs of hearing impaired students as modified for the science teaching environments and supplemented, as appropriate, from the experiences of the writing group (Keller, 1978-79; Keller and Keller, 1978), from the literature, and from the reviewers of this resource book.

1) The Need to have Persons Who Understand the Meaning of Impaired Hearing.

In the words of Calhane and Mothersell (1979), "Hearing impaired students need both teachers and resource people who are aware of and understand the ramifications of hearing loss and its resultant communication problems. A recent hearing test by a certified audiologist should be required, and the diagnosis and prognosis will need to be explained." To make effective use of the audiologist's report, a teacher will need to be aware of the following factors.

Hearing aids amplify sounds, but they cannot compensate for a problem such as hearing distorted sounds. A student with a conductive loss, for example, may benefit greatly from amplification, while a person with a sensori-neural loss and, hence, difficulty discrimating among sounds, may derive less benefit from the use of a hearing aid. If a person hears a sound in a distorted way, a hearing aid merely makes the distorted sound louder. (Individuals with sensori-neural losses can, however, learn to use their residual hearing to interpret distorted auditory patterns especially in conjunction with speech reading.)[1] Also, because abnormal sensitivity to loud sounds may be associated with certain types of hearing impairments, some individuals may not be able to tolerate the amplification generated by a hearing aid—though some of the newer hearing aids protect the wearer from sudden loud noises.

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[1] Speech reading is equivalent to the earlier term "lip reading", plus the simultaneous use of other visual clues.

The use of residual hearing is another factor that instructors should understand. Individual students who have residual hearing will vary, not only in the extent and nature of the amount of hearing that remains, but also in their ability to use that hearing. In many cases, auditory training can assist those persons who have residual hearing to better identify and recognize speech and non-verbal sounds.

The age of the individual at the onset of the hearing disability is a variable that has a profound effect on communication problems. A hearing loss present at birth or occurring early in life (prelingual) can significantly interfere with the development of speech and language. Persons who suffer a hearing loss after having acquired language (postlingual) are generally less functionally handicapped (Lang, 1979).

Deafness is an invisible handicap. Consequently, it is very easy for people to "forget about it" and to treat the student as a non-handicapped person. Also, hearing impaired students learn to fake comprehension with the end result that the teacher does not teach and the student does not learn. Because of this invisibility, hearing impairments, more than most other physical handicaps, require that the instructor constantly remind himself of the student's handicap.

2) The Need for Opportunities to Communicate

Because a hearing impairment can so easily produce isolation, hearing impaired students need many opportunities to communicate. The various ways in which deaf people communicate comprise three general categories: the **oral, manual,** and the **simultaneous methods of communication.** The **oral method** consists of an emphasis on the student developing speech and skill in speech reading. The oral method also stresses writing skills and expertise in the English language. Speech reading is generally inadequate for total understanding, however, since only about 30 percent of spoken English is visible on the lips (Foster, et al. 1977). A more recently developed method, cued speech, makes use of specific hand shapes presented at the side of the speaker's mouth to differentiate between confusing speech sounds, thereby increasing the speech reader's comprehension of spoken language. This method of communication is not in widespread use.

Familiarity with a given person greatly enhances the ability of a hearing impaired person to speech read that person; and, with time and practice, an easy conversational mode can develop. Speaking often with a student in the laboratory or classroom or during free time is most helpful.

Manual communication is a special mode of communicating through the use of **signs** and **fingerspelling.** Either English or ASL (American Sign Language), which is a system of meaningful gestures, can be communicated in this manual mode (sign language). The deaf student in class may be skilled at either one or both of these languages.

Simultaneous, or **the combined method,** is an approach encompassing a number of communication modes, speech, speech-reading, writing, signing, fingerspelling, body language, cued speech, and gesturing—in combinations which are most effective for the specific hearing impaired individual. The term "total communication" has received wide attention in recent years. Some educators refer to it as an extension of the simultaneous method, while others see it as a system that assists hearing impaired students on the basis of individual needs (Moores, 1978).

The use of an interpreter is an option chosen by some hearing impaired students. The interpreter may both transmit spoken messages to the hearing impaired person and transmit (by means of speech) the hearing impaired person's messages to an audience, or to an individual having normal hearing.

As described by Lang and Caccamise (1980), an educational interpreter may use one of two methods, either translating or interpreting. Translating (or Translation) is a word-for-word representation of a speaker's actual message, with only slight wording revision (so that it can be conceptually understood by the student). Interpreting involves presenting the speaker's message in the optimal communication mode used by the individual student (i.e., in ASL or other sign language system). Conceptually, the message should remain the same, but there will be revisions in the words and word order. A teacher should be aware of which method a student and interpreter are using, since in ASL the student may be receiving a somewhat different presentation. This is just one of the reasons why the instructor and the interpreter should work together closely.

Interpreters vary in their interpreting skills and in their knowledge of science. Thus, the use of registered interpreters (RID) and those who are familiar with science content is prefereable when they are available. Depending upon the student's primary mode of communication, an interpreter may be either a **manual (sign language) interpreter,** or an **oral interpreter.** A manual interpreter interprets or transliterates into sign language. An oral interpreter repeats the speaker's message by mouthing the words to the student. Since few oral interpreters are available, most students who use the oral method will depend upon speech-reading the teacher. However, note that oral interpretation may have to be provided under special circumstances such as during films or for television presentations.

It is somewhat controversial where the interpreter should stand or sit. Some individuals prefer that the interpreter stand next to the instructor. Others feel that this method will be to distracting for the other members of the class.

Alternatives include having the interpreter directly in front of the hearing impaired student with both the hearing impaired student and the interpreter off to the side of the classroom or, again, having the interpreter directly in front of the student with the student in the front row midway between the center front and the far side of the classroom. Also, the instructor should feel free to use note writing or a chalk board for one-to-one communication with the hearing impaired student. The interpreter should also be available for field-trips, assemblies, laboratories, discussions, etc. (Foster et al., 1977). Of course, even when an interpreter is present, the teacher may communicate directly with the student.

Certain general strategies are listed below for teachers working with an interpreter (mostly from Lang and Caccamise, 1980):

- Take time at the outset of the course to discuss with the interpreter and the class the interpreter's role in the classroom.
- Do not direct comments to the interpreter, speak directly to the hearing impaired student.
- Inform the interpreter daily of the class format (lecture, laboratory, films, group discussion, etc.).
- Minimize movement such as pacing when possible and remain in close proximity of the interpreter to allow the student concurrent full view of the teacher, interpreter, and blackboard.
- When using educational media, build in natural pauses to allow time for hearing impaired students to receive the message from the interpreter and to then look at the overhead, slide, or chalkboard information. The hearing impaired individual cannot simultaneously receive two forms of visual information.
- Speak clearly, at a moderate pace, without exaggeration.
- Avoid the use of highly idiomatic terminology and the excessive use of abstractions (many hearing impaired students are not familiar with "standard" English idioms). Subsequent explanation of the idiom can result in loss of valuable class time and may even confuse the hearing impaired student more since its relationship to the subject will probably not be clear.
- Provide both the student and the interpreter with a list of any new concepts or technical vocabulary well in advance of the activity.
- Provide a brief outline of the lecture to the interpreter and the hearing impaired student in advance.
- Provide the interpreter with scripts of films and other educational media when possible.
- Because it is extremely difficult for the hearing impaired student to speech-read video tapes, provide alternative communication modes such as a script.

Encourage the hearing impaired student to participate in group discussions, especially if he shows a pattern of non-participation. As Gavin et al. (1981) point out, the deaf student often encounters great difficulty and embarrassment entering into group discussions.

3) The Need for Visual Access to Information

The major effect of any hearing loss is increased dependence on the visual mode for the acquisition of information (Cain, 1981). There should be an emphasis on the use of all modes of visual aids with the hearing impaired student, i.e., films (see captioned films availability, page 39), film loops, overhead projectors, slides, and models. When the room is darkened for a non-captioned film, remember to provide lighting on the interpreter and/or speaker in order to guarantee the hearing impaired student's reception of the oral aspect of the presentation.

It is difficult for the hearing impaired to take complete class notes during lectures, since it is impossible to simultaneously look down and write and to also watch the speaker or interpreter. The student should be encouraged to take notes on major points, but should also be provided with class notes from the instructor or a peer.

The teacher should be aware that while looking at the speaker or interpreter, the hearing impaired student cannot also look at an object or at the chalkboard. Moreover, there is a delay between the time the instructor is describing an object and the time that the student will begin looking at the object. This time lag may cause the student to mis-associate a phrase meant to describe one of a series of indicated objects. A conscious pause by the lecturer at an appropriate place will avoid this problem (Cain, 1981).

Another kind of problem is the presence of visual distraction or "noise" (Gavin, et al. 1981). A blinking light, moving people, or a flapping curtain can be as distracting to a hearing impaired person as a loud background sound is to hearing students. Visual clutter on a chalkboard, bulletin board, or chart is also visual distraction.

In the laboratory, experiments dependent upon the auditory sense can often be performed using a visual mode. The Doppler effect can be demonstrated by a ripple tank as well as by a train whistle. A spring can demonstrate compressional waves, while other experiments with sound may utilize oscilloscopes or computer-generated sound spectrograms (Cunningham and Lang, 1978-79).

An apparatus or application of a principle or concept which visually reinforces an auditory perception will help both hearing impaired students move from the concrete into the abstract (Cunningham and Lang, 1978-79).

The science teacher will greatly assist the hearing impaired student by conscientiously communicating schedule changes, changes in procedures, daily topics, reading assignments, etc., in a clear manner—for example, writing on the chalkboard. Clear written instructions provided prior to a laboratory or field trip will also greatly facilitate the understanding of laboratory field procedures and objectives (Gavin, et al., 1981).

Students whose hearing became impaired early in life often read at levels below those of their hearing peers (Cain, 1981). This does not imply that all hearing impaired students read below level or that they have a lower I.Q. or less ability to acquire science concepts. However, it means that teachers may need to adapt teacher-prepared reading materials and to be aware of the difficulty of the level of assigned reading with respect to the reading ability of their hearing impaired student(s).

It is impractical for a teacher in a mainstreamed class to produce adapted reading materials. Rewriting text books is beyond what a teacher should be asked to do. However, a teacher preparing his own materials—e.g., tests, instructions, laboratory handouts, etc.—may find the following strategies helpful (after the summary of Colladay, in Bishop, 1979).

- Break up long sentences by making two or more shorter sentences or use simple compound statements of the and/or types.
- Reduce the difficult vocabulary load when possible, retaining only the essential technical vocabulary.
- Reduce concept density by introducing only a few related concepts within a single written lesson.
- Make information relevant to student experiences when possible.
- Limit the use of relative pronouns. Use only when the antecedent or referent is unmistakable.
- Don't omit "that" when used to clarify a sentence connection.
- Use simple coordinating conjunctions (e.g.; but, so, for, and), not transitional words (e.g.; however, as a consequence, nevertheless, although).
- Keep cause and effect (result) sentences very simple.
- Use conditional expressions sparingly and carefully.
- Use word frequency lists to replace a word with a more familiar synonym. (You can also ask the interpreter about a replacement word which has a related sign.)
- When a new or difficult term is used, use a brief parenthetical explanation beside it.
- Be concise without being redundant.
- Use a handout list of guiding questions with the readings.
- Place illustrative sketches, diagrams, and graphs near the information or explanation in the text or reading.
- Use mnemonics to orient the student to newly acquired information.
- Be aware of your student's level of cognition (note comments on page 28 on the cognitive lag.)
- When explaining concepts, begin by introducing the main idea, then present concrete information, details, and examples, and finally move from the concrete to the abstract.
- Reduce the use of:
  - Passive voice verbs.
  - Negative forms of verbs.
  - Excessive modifiers such as prepositional phrases and relative clauses.
  - Idioms and colloquial expressions.
  - Rhetorical inversions.
  - Word plays or puns.

4) The Need for Opportunities for Experiential Learning

Instead of "talking about it" the class should "do it" whenever possible. "The hearing impaired student can increase: language performance, observing and listening skills, vocabulary, the learning of science concepts, and the development of cognitive skills through direct sensory experience in science," according to Brown (1978-79). This is true for all students, but it is particularly significant for the hearing impaired considering their tendency to exhibit both cognitive and language lags due to experiential deprivation (Furth, 1973). Tomlinson-Keasey and Kelly (1974) describe how the lack of auditory feedback and experiential deprivation provide far fewer opportunities to develop abstract thinking processes. Collea (1976) suggests a strategy for easing the attainment of language through real and meaningful experiences, i.e., by direct manipulation and experimentation with real objects.

5) The Need for Opportunities for Incidental Learning

One of the major ways we learn is through incidental "non-deliberate" learning (Culhane and Mothersell 1979). Incidental learning provides opportunities to observe, to guess, to categorize, to generalize, and to evaluate—which are all fundamental mental processes. But although many avenues of incidental learning are limited or unavailable to the hearing impaired student, the science classroom can provide the opportunity to teach these mental processes. These processes have been stressed in certain science curricula (Gagne, 1966).

It is important for hearing impaired students to have nonstructured, real-life opportunities to foster their natural curiosity and to experience trial and error activities (Culhane and Mothersell, 1979). Such opportunities are normally plentiful in the science classroom. In addition, Collea (1976) points out that for a program to be used successfully with hearing impaired students, it should provide for the repetition of concepts and the words describing them. Because of a general lack of incidental learning, hearing impaired students do not experience the informal repetition of many basic concepts as do their hearing peers. A science teacher's effort to provide repeated contacts with concepts and the linguistic structures—sentences, phrases, and vocabulary—will be of great benefit to the hearing impaired student. One way that incidential learning could be achieved is with poster or bulletin board displays or with working exhibits located in the classroom.

6) The Need for Opportunities to Develop Self-Esteem

Hearing impaired students need to value themselves, their ideas, and their opinions. Too often they view knowledge as emanating from external authorities only (Culhane and Mothersell, 1979). The tendency, expressed by minority students in general, to feel isolated, to lack role models and to fail to develop realistic goals. This is exacerbated for hearing impaired students by the problems related to language input and output (Kopp, 1979). The science classroom, and a sensitive teacher, can help to alleviate some of these feelings.

7) The Need for Role Models

Hearing impaired students often have poorly defined career objectives. Therefore, they need role models, both hearing impaired role models (like Thomas Edison) and role models with normal hearing (like Albert Einstein) (Culhane and Mothersell, 1979).

According to Lang (1979), "Many deaf students have never learned of deaf notables such as England's Cornforth (1976 Nobel Prize winner in chemistry) and America's Thomas Edison, both potential role models for inspiring careers in science for the hearing impaired."

8) The Need for Multi-level Learning Opportunities

As Culhane and Mothersell (1979) note, "hearing impaired students need opportunities to experience all levels of understanding. They need to be taught basic life skills (which others learn incidently), just as they need to deal with complex theoretical issues at appropriate times in their cognitive development." Hanner et al. (1971) describe some general "information processing" traits of hearing impaired students in the science classroom. These traits are also characteristic of hearing students, but to a lesser extent. Hanner et al. also state that hearing impaired students tend to learn by using rote memory rather than from understanding. Hearing impaired students may also have difficulty reasoning logically and tend to over-simplify problems and to respond hastily and without careful analysis. Lang (1979) adds the observation that hearing impaired students often have difficulty applying knowledge learned in one context to the solution of other problems as well as difficulty identifying exceptions to a principle. Also, Hanner et al. (1971) point out that hearing impaired students may be reluctant to admit that they do not understand something. The teacher must be sensitive to these problems and attempt to provide both a rich environment and increased experience with abstractions. "Deaf students need strong (but reasonable) demands to stimulate logical, creative, and effective thinking in the science classroom and laboratory" (Lang, 1979). Lang also points out that if topics are structured so that new knowledge can be easily related to concepts already acquired, the student will be able to advance from the simple to the more complex, from the concrete to the more abstract, from the practical to the more theoretical aspects of science. For example, Higgins (1971) used the concept of wind to begin the study of gases.

9) The Need for Academic Success

Hearing impaired students should be placed in programs suitable for their skills and encouraged to proceed from there to achieve greater success. Most of all, they should be spared devasting feelings of incompetence due to the absence of successful experiences or to a series of failures (Culhane and Mothersell, 1979). Gavin et al. (1981) note that because hearing impaired persons have difficulty in detecting subtle verbal messages, praise (and, when necessary, criticism) must be given to them in a clear and unequivocal manner. Unless care is taken, a hearing impaired person could confuse applause with derision.

10) The Need for Successful Social (Academically Related) Functioning

Gavin et al. (1980) point out that a hearing impaired student may have problems interacting with his hearing peers (and also his hearing impaired peers) because of certain problems in communication. The teacher should closely monitor the hearing impaired student's progress until the instructor feels that he has established meaningful and worthwhile relationships with those around him. Gavin et al. (1981) state that the selection of a congenial partner, or group, for the hearing impaired student (as opposed to random assignment) will help the hearing impaired student in science. In addition, it could be a step toward improving the overall social interaction in the classroom. Hearing impaired students may need to be reminded or perhaps even taught about customs and courtesies established by a predominantly hearing society. They sometimes miss subtle distinctions in manners, which aid in establishing and maintaining positive personal relationships. Certain comments on improving participating in group discussion and interaction presented in the following Section (III) also apply here. Gavin et al. (1981) conclude that the teacher/student equation is most important. The teacher sets the tone and establishes the attitudes that will determine the environment of the classroom; the hearing impaired student's peers will follow the instructor's lead.

11) The Need for Recognition as Individuals Who Happen to Have a Hearing Impairment

Students with a hearing impairment need to be recognized as individuals first and as hearing impaired students second. They need to be perceived as normal young adults with the same emotions, drives, aspirations, and energies as hearing adolescents. Do not stereotype students who have hearing impairments. There is as much variation in the abilities of hearing impaired students as there is in students without hearing impairments.

The teacher must provide the understanding that allows the student to be accepted as a "normal" adolescent or youth. Gavin et al. (1981) suggest that the teacher inform the class at its first meeting that a hearing impaired student is taking the course (with prior discussion and concurrence of the hearing impaired student) to determine if any students would be willing to share notes, for instance. The announcement should help to stimulate total involvement of the hearing impaired student and to ease the way for his acceptance as an equal.

SECTION III. SPECIAL MITIGATIVE STRATEGIES: THE REFERENCE TABLES

This section concerns the specific mitigative strategies for the seven common teaching aspects in science as presented on page 5. These are: teacher presentation, laboratories, field trips, reading, group interaction and discussion, AV/tactile, and research problems. Teaching strategies given here for hearing impaired students are not unique to the science classroom. Rather, most mitigative strategies for hearing impaired students center around neutralizing the problems of communication that could occur in any classroom. The hearing impaired student's greatest need is for teachers who understand the implications of the disability in such areas as language acquisition, reading abilty and cognitive growth. Instructors are therefore strongly encouraged to carefully read the second section of this chapter for an understanding of the general needs of hearing impaired students. These general needs are as important (if not more so) as applying the specific mitigative strategies given in Table 7.

For this section of the book, we have categorized the characteristics of hearing impaired individuals by the individual's ability to function in the classroom and in the general teaching environment. No two hearing impaired students will function in identical ways. This is dependent on: 1) whether or not they need the services of an interpreter (oral or manual), 2) the level of their speech-reading skills, 3) their ability to make use of residual hearing, 4) their preferred mode of communication (sign language, manual alphabet, speech-reading, or total communication), 5) their self-confidence, 6) their comfort level in the teaching environment, and 7) their degree of language deprivation (pre- or post-lingual deafness). We have distinguished among students who (A) depend primarily on their **residual hearing,** (B) those who depend primarily on **speech-reading,** and (C) those who depend primarily on **sign language and/or fingerspelling.** But in using this section of the book, it must be remembered that each student has his own preferences, weaknesses, and strengths, and that each student must be assessed and treated as an individual.

A. The student primarily depends upon residual hearing (with or without amplification) for communication.

This individual is only slightly hard of hearing, and may or may not wear a hearing aid. He functions in much the same way as a normally hearing person, but may not cue on sounds as accurately and may need more points clarified due to missed information. Mary, for example, can take notes if sitting near the front of the room, but needs an understanding teacher who remembers to cue her if she is not paying attention or does not understand. The instructor should also realize that such a student may periodically miss a word or an idea. This student can benefically use those strategies that promote better listening.

B. The students primarily depend upon speech-reading for communication.

Such an individual may or may not have the use of residual hearing and may or may not use a hearing aid. This individual does not use manual communication, and may or may not need an auditory/oral interpreter for transliteration. Paul, for example, sits near the front of the room and speech-reads a cooperative teacher, who speaks only when facing the class. The instructor cues the student when others are speaking by a head nod or subtle pointing. Ed wears an aid and prefers the service of an oral interpreter in addition to speech-reading the teacher. Both of these hearing impaired students have good English language skills, but that will not be true of all individuals in this category.

C. The student primarily depends upon sign language and/or fingerspelling for communication.

These individuals may or may not have the use of residual hearing. They may or may not have speech-reading skills. These individuals primarily use the manual alphabet and/or sign language as the preferred mode of communication, and they will probably depend upon a manual interpreter in the classroom. Barbara has a good deal of residual hearing and good speech capabilities and she communicates easily with non-signers one-on-one. But she prefers manual sign language among friends and uses a manual interpreter in the classroom. She has good English skills. Ernie who has very little use of his residual hearing, depends entirely upon sign language and the manual alphabet for communication. He also needs adapted reading materials in his educational program. Tom also has very little use of residual hearing, but uses mainly the manual alphabet for communication, using very few signs. He has very good English skills and a large vocabulary.

It is evident that there is variation both among and within these three groupings. In fact, some individuals may change their primary mode of communication, depending upon the situation. For example, a person who normally uses sign language may rely on speech-reading when conversing with non-signers. Hearing impaired individuals in all of these groups have a common characteristic, however: a potential or real communication problem.

How to Use the Reference Tables

In Table 6 the seven teaching aspects are followed by the appropriate set of possible mitigative strategies for each hearing-impaired functional group. These mitigative strategies can be used to neutralize the educational deficiency caused by the handicap.

EXAMPLE

Possible strategies useful in science education for hearing impaired students are listed as numbers after the group for which they are found to be most beneficial. For example, if an instructor wanted to know what he needed to do to provide an optimal reading assignment for a student who depends on manual communication (group C), the instructor would refer in Table 6 to the teaching method titled "Reading," locate Group C, and obtain the list of mitigative strategies listed there. He would then refer to Table 7. In this case, the strategies referenced from Table 6 are:

3.06 Write new vocabulary on the board before a lesson or laboratory.
3.09 Write all homework assignments, class instructions, and procedural changes on the chalkboard.
3.10 Adapt reading materials when necessary and provide resource materials at suitable levels.
4.02 Make extensive use of glossaries.
5.02 Provide a student's speech therapist or speech-reading teacher with a list of science vocabulary words and a textbook to use in practice.

TABLE 6. INSTRUCTIONAL METHODS AND MITIGATIVE TEACHING STRATEGIES (MTS) FOR STUDENTS WHO:

A = PRIMARILY DEPEND UPON RESIDUAL HEARING (WITH OR WITHOUT AMPLIFICATION) FOR COMMUNICATION[1]
B = PRIMARILY DEPEND UPON SPEECH-READING FOR COMMUNICATION.
C = PRIMARILY DEPEND UPON SIGN LANGUAGE/MANUAL ALPHABET FOR COMMUNICATION.

Note that groups B and C are combined for the purposes of suggesting MTS's. However, the teacher should be searching for modifications in the strategies to accomodate the variations among individuals in these two groups.

TEACHING METHOD: TEACHER PRESENTATION[2]

MTS: A 1.01, 1.02, 1.03, 1.04, 1.05, 2.04, 2.08, 2.09, 2.12, 2.13

B and C 1.01, 1.02, 1.03, 1.04, 1.05, 1.10, 2.01, 2.03, 2.04, 2.05, 2.06, 2.07, 2.08, 2.09, 2.10, 2.11, 2.12, 2.13, 2.14, 3.01, 3.05, 3.06, 3.07, 3.08, 3.09, 3.11, 3.13, 3.14, 3.15, 3.18, 3.19, 3.22, 4.01, 5.01, 5.02, 5.04

TEACHING METHOD: ACTIVE AND PASSIVE LABORATORIES

MTS: A 2.09

B and C 1.06, 1.08, 1.09, 1.10, 2.01, 2.02, 2.03, 2.04, 2.07, 2.08, 2.09, 2.11, 2.12, 3.03, 3.04, 3.06, 3.07, 3.10, 3.16, 3.17, 3.20, 4.01, 5.03

TEACHING METHOD: ACTIVE AND PASSIVE FIELD TRIPS

MTS: A 2.09

B and C 1.02, 1.10, 2.01, 2.03, 2.04, 2.08, 2.09, 2.12, 3.01, 3.03, 3.06, 3.07, 3.16, 3.17, 3.20, 4.01, 5.03

TEACHING METHOD: READING[3]

MTS: A None

B and C 3.04, 3.06, 3.10, 4.02, 5.02

TEACHING METHOD: GROUP INTERACTION AND DISCUSSION

MTS: A 1.05, 2.03, 2.04, 2.07, 2.09, 2.12

B and C 1.02, 1.05, 2.01, 2.02, 2.03, 2.04, 2.08, 2.09, 2.10, 2.12, 3.05, 3.21, 3.22, 4.01, 5.01

TEACHING METHOD: AV/TACTILE[3] [4]

MTS: A, B, and C 1.07, 2.01, 2.05, 2.11, 3.02, 3.06, 3.07, 3.12, 4.01, 4.03, 5.01

TEACHING METHOD: RESEARCH PROBLEM[5]

MTS: A None

B and C 3.10, 4.01, 4.02, (also including laboratory MTS)

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[1] Students in group A will function much the same as normally hearing students.
[2] This is assuming that there will be little or no discussion. If discussion and questions are used, refer to the section on group interaction.
[3] This method can be used to supplement other teaching methods.
[4] Group A students may require increased volume.
[5] The research problem may also include strategies from all other teaching methods.

TABLE 7. MITIGATIVE STRATEGIES FOR THE HEARING IMPAIRED

1.0 STRATEGIES INVOLVING THE PHYSICAL ENVIRONMENT

1.01 Place the student within 15 feet of the lecturer (for signing); 5 to 8 feet for speech-reading and ***audition FM unit;*** 2 to 5 feet for personal hearing aid and speech-reading.

1.02 Seat the student with his better ear towards the class.

1.03 Avoid seating student in heavy traffic areas.

1.04 Avoid lighting difficulties.[1]

1.05 Avoid vibrations and excessive noise.[2]

1.06 Assign student to a laboratory station that allows an unobstructed view of the instructor and/or interpreter.

1.07 Provide a soft light on the interpreter near the A/V screen during the presentation of non-captioned media.

1.08 Provide indicator lights where possible for on/off status of equipment.

1.09 Supplement audible alarm systems with simple visual alarms such as flashing lights.

1.10 Establish, with the student, a procedure in case of emergency. For example, agree that for firedrills the teacher will write on board "Firedrill—go out backdoor."

2.0 COMMUNICATION STRATEGIES

2.01 Insure the presence of an appropriate interpreter where needed.[3]

2.02 Communicate directly with the student whenever possible, whether an interpreter is present or not. Feel free to use note-writing or chalkboard with the student for one-to-one interactions.

2.03 Use visual cues to attract the student's attention in addition to the vocal signal.

2.04 Obtain feedback from your student at every opportunity as an indicator of the student's level of understanding.

2.05 Present only one source of visual information at a time.[4]

2.06 Avoid standing in front of window or light source that may silhouette the lecturer and hinder visual cues (facial expressions, gestures, etc.).

2.07 Speak clearly, at a moderate pace, without exaggeration or over-enunciation.

2.08 Face the class when you speak, making eye contact.

2.09 Engage the hearing impaired student's attention before communicating with the class.

2.10 Identify who is speaking or asking a question.[5]

2.11 Maximize the use of visual media.

2.12 Use of appropriate auditory amplification equipment.

2.13 Do not talk while writing on a chalkboard.

2.14 Use an overhead projector so the instructor can simultaneously face the class and write on the screen.

3.0 TEACHER STRATEGIES

3.01 Provide an outline of the lesson/activity and handout to the student in advance, and give your expectations.

3.02 Provide scripts of films and other media when possible.

3.03 Provide concise, step-by-step directions prior to a laboratory activity and preview it with the student if possible.

3.04 Insure that the student receives information about any changes in experimental procedure by writing on the board or on paper.

3.05 Repeat new vocabulary in different contexts for reinforcement.

3.06 Write new vocabulary on the board before a lesson or laboratory.

3.07 Preview and review activities and objectives in special sessions with the student.

3.08 Make board notes legible.

3.09 Write all homework assignments, class instructions, and procedural changes on the chalkboard.

3.10 Adapt reading materials when necessary and provide resource materials at suitable levels.[6]
3.11 Use media when introducing new concepts and vocabulary.
3.12 Use captioned materials, when possible.[7]
3.13 Avoid the use of abbreviations except for standard ones.
3.14 Sequence topics so that new material is related to that previously learned.
3.15 Begin explanations with concrete examples, working from the concrete to the abstract.
3.16 Allow for direct manipulation of materials, whenever possible.
3.17 Label equipment and materials to aid in the learning of vocabulary.
3.18 Cue the student to relevant pages in written materials by handout or by writing page numbers on the chalkboard.
3.19 Repeat explanations in another way when student does not understand.
3.20 Adapt activities using the auditory sense to a visual mode.[8]
3.21 Familiarize the hearing impaired student with the common language used by other students in the class.
3.22 Be sure that the hearing impaired student knows which topic is being discussed.

4.0 STUDENT STRATEGIES

4.01 Ask questions (hearing impaired students are often reluctant to ask questions).
4.02 Make extensive use of glossaries.
4.03 Take notes on major points in a lesson.

5.0 ASSISTANCE FROM OTHER PEOPLE

5.01 Arrange for a notetaker if no other means for acquiring notes is available (a trained notetaker would probably assure better accuracy).
5.02 Provide the student's speech therapist or speech-reading teacher with a list of science vocabulary words and a textbook to use in practice.
5.03 Assign a congenial hearing laboratory partner for experiments relying solely on sound.
5.04 Arrange for students to use tutorial services (experience indicates that the choice of tutors must be made with care.)

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[1] Reduce glare on speaker, A/V materials, etc. by closing blinds. Face student away from bright windows, remove fluttering shadows or flashing lights, which tend to distract hearing impaired students.

[2] Ambient noise level must be minimal, since hearing aids amplify all sound nonselectively.

[3] See Section II, pages 29-30.

[4] i.e.,do not talk while writing on blackboard or putting written material on an overhead. The student cannot "read" your lips and the written material at the same time.

[5] Make sure all instructor comments are either: 1) communicated by the interpreter, or 2) repeated by the interpreter. Otherwise, ask speakers to come to the front of the room.

[6] See Section II, page 31 for guide to modifying textural materials for the deaf.

[7] Information on captioned film centers and film lists are available through the Gallaudet College Media Library at 7th and Florida Ave., Washington, D.C. 20002.

[8] See Section II, page 31 for note on the adaptation of auditory teaching modes to visual ones.

CHAPTER IV

THE MOTOR IMPAIRED/ORTHOPEDICALLY DISABLED

SECTION I. LIFE FUNCTION IMPAIRMENT

The term "orthopedically handicapped" includes a heterogenous grouping of conditions with a wide range of causes. It is difficult to characterize this group; however, there are common functional limitations within the group. To encompass the broad range of conditions, we have chosen to use the term MIOD (motor impaired/orththopedically disabled) to distinguish this grouping from the other two major types of disability: vision and hearing impairments (Lang et al., 1982).

The Need to Access Life Function Impairment

One of the first considerations in the effective education of the MIOD student is an understanding of his impairment and the degree of educational limitation it causes. With such information,a set of mitigative strategies can be derived that are specific and fully appropriate to that particular student. Gaining an understanding of a student's impairment and educational limitations can be difficult. As Calhoun and Hawisher (1979) note, "the combination and permutation of levels and types of motor impairment plus the number and levels of related disorders are limitless."

There is a traditional classification of MIOD individuals: **orthopedic conditions, muscle system impairment,** and **neuro-muscular disorders** (White, 1978). Orthopedic conditions primarily affect the skeletal system, the joints, and the connective tissue (e.g., tendons and ligaments); muscle system impairment involves only muscle tissue; and neuro-muscular disorders concern impairments of motion and speech due to damage of some part of the central nervous system, i.e., brain and spinal cord. This system, however, does not provide a thorough understanding of the nature of the MIOD student's disability as it relates to educational limitations. A related problem is that people who rely on the traditional classification tend to think largely in terms of the degree of disability (limps, uses a cane, uses crutches, uses a wheelchair, etc.) rather than in terms of what particular individuals are capable or not capable of doing.

We have therefore used a functional system of characterization, which is the **Life Function Impairment Assessment System** (Dudek et al., no date). It is presented in Table 8. By defining disabilities in terms of function, this system gives the instructor much better insight into the actual limitations caused by the disability and since these are what affect educational activities it makes it much easier for the instructor to select appropriate mitigative strategies for each student.

In this system there are five general disability areas: **Motor/Orthopedic, Behavior, Chronic Disease** (such as emphysema or diabetes), **Auditory,** and **Visual.** There are, in addition, five categories of functional impairment, areas of living that can be affected by a disability. The five categories of functional impairment are listed below:

1) **Health** - refers to the physical and physiological functioning of the individual.
2) **Mobility** -refers to operating and negotiating in the physical environment.
3) **Communication** - refers to sending and receiving messages with people and the environment. It includes hearing and vision.
4) **Social/Attitudinal** - refers to regarding oneself positively and interacting successfully with others.
5) **Cognitive/Intellectual** - refers to interpreting events, learning, and applying learning.

The two strengths of this system are that it: 1) recognizes the possibility that a disability in one of the five general disability areas can potentially create difficulties in more than one category of functional impairment and 2) that multipically handicapped individuals can be equitably assessed. For instance, a hearing-impaired individual can also have health disabilities (such as brain disorders), mobility problems (such as poor balance), communication problems (in addition to hearing: for instance, speech), social and attitudinal problems (social isolation and lags in social/emotional development and cognitive and intellectual problems (difficulty in learning). Also, an individual can have functional impairments stemming from more than one disability—for instance, an orthopedic problem coupled with impaired hearing. In such a case, any life function impairment caused by either disability would be recorded in the appropriate box below that generally disability area. This table can be used by instructors or other school personnel to carefully consider the full extent of a student's functional impairment.

TABLE 8. GENERAL RELATIONSHIP BETWEEN TYPES OF FUNCTIONAL IMPAIRMENTS AND LIFE FUNCTIONS[1,2]

	General Disability Area				
Life Function	Motor/ Orthopedic	Behavior	Chronic Disease[3]	Auditory	Visual
Health					
Mobility					
Communication					
Social/ Attitudinal					
Cognitive/ Intellectual					

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[1] This table is after that given in the Technology Assessment Report on Human Rehabilitation Techniques by R.A. Dudek et al., (no date). Texas Tech Univ.

[2] In use, each block of the table would be filled in with some indication as to the degree of impairment for the individual student being assessed (see Table 9 as an example).

[3] For example, emphysema or diabetes.

[4] The rating given in each cell reflects the degree of potential functional impact that could exist between a disability area and the life function of a disabled person. *In practice, the assessment would be completed for just one individual, as done in Table 9.* The rating scale used can be any quantitative scale indicating the degree of functional loss.

TABLE 9. LIFE FUNCTION IMPAIRMENT ASSESSMENT FOR A PARTICULAR MALE SPINA BIFIDA STUDENT[1]

		General Disability Area			
Life Function	Motor/ Orthopedic	Behavior	Chronic Disease	Auditory	Visual
Health	Some Problem[2]				
Mobility	Severe Problem[3]				
Communication	No Problem				
Social/ Attitudinal	Significant Problems[4]				
Cognitive/ Intellectual	Some Problem[5]				

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[1] This example assessment is for a student in our Marine Science Summer Program. It is NOT a general assessment for all students with spina bifida.

[2] Use of urine bag is necessary. Time must be scheduled for emptying.

[3] Most of the time is wheel-chair bound. Can use crutches for short distances and can transfer to chair or bench from wheelchair.

[4] Has great difficulty making and keeping friends. Part of the problem is that urine odor causes avoidance by peers. Uses wheelchair aggressively, makes inappropriate use of vulgar language. Disrupts class with outbursts and unrelated information. General lack of self-discipline and respect for authority.

[5] Problem of depressed grades, despite average I.Q. No indication that this problem is directly due to disability, but he was a home-bound student through the 4th grade.

Although we believe that some form of life function assessment should be completed for each student, we have not dealt with life function impairment assessment systems in the chapters on hearing and visual impairments. This is because with hearing and visually impaired students the main emphasis must be on developing adequate communication strategies, while the special strength of the Life Function Impairment Assessment System is that it indicates the wide range of life function limitations that can be caused by a disability. The Life Function Impairment Assessment System is particularly valuable with MIOD students, since MIOD disabilities tend to have a broader range of life function impairments.

Sample Assessment

The following is an example of how the Life Function Impeirment Assessment System could be used to develop appropriate mitigative strategies for a particular student. The student has spina bifida and is, for the most part, wheelchair-bound. He is a high school sophomore interested in engineering. The assessment of this student, which is shown in Table 9, indicates one general health problem: need for a urine bag. He also has severe mobility limitations, some social/attitudinal problems, and a moderate cognitive/intellectual problem (probably not directly associated with his disability). He has no communication problems.

Once all the relevant life function impairments have been identified, the student and instructor can choose the appropriate mitigative strategies, as explained elsewhere in this book. (To find specific mitigative strategies for MIOD students, see Section IV of this chapter.)

It is also possible to use the principles of the Life Function Impairment Assessment System without actually completing the table. Below are two non-tabular assessments of disabled students. The first is a student with moderate to severe arthritis and, hence, with difficulty in the movement of his joints. Careful observation of the student's performance on motor tasks would be a necessary supplement to examining the student's relevant medical records. It might be determined that the student's impairment in mobility is his only significant life function impairment. Other than the impairment in mobility, the only other problem might be occasional behavior problems caused by the high level of pain associated with the disability. The instructor who is sensitized to these problems would have little difficulty taking appropriate mitigative measures. Possibly the only educational modification would be allowing the student to avoid prolonged standing or walking.

The second non-tabular assessment is for a MIOD student who has severe cerebral palsy (CP). His assessment would be very different from that given above. Although cerebral palsy affects individuals in different ways, it is likely that a severely disabled student with CP would require extensive assistance in most or all of the five life function categories. Just within the single life function area of mobility, several mitigative strategies would be necessary. Since the student would probably be using a wheelchair, ramps or an elevator would be necessary to enable the student to enter the classroom or laboratory. Low laboratory benches[1] would also be necessary as well as wheelchair-accessible restrooms.

Summary

One of the first considerations in teaching the MIOD individual is the teacher's understanding of the nature of the student's disability and the degree of learning needs related to the physical impairment. In many cases, the teacher's accurate identification of the special needs of MIOD students will be difficult; however, the use of the Life Function Impairment Assessment System will result in an excellent early establishment of appropriate mitigative strategies. To conduct an accurate assessment the teacher or the school representative should do many or all of the following: speak with the student, his prior instructors, his parents, his doctor, and perhaps others; examine the student's relevant medical and academic records; and continually observe the student's abilities and limitations in the classroom.

Since the impairments are in many cases multiple, teaching such students may require a variety of mitigative teaching strategies.

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[1] Recently, tilting, stand-up, and adjustable height wheelchairs (with hydralic jacks) have become available for those non-ambulatory students in laboratories with stand-up height laboratory benches (Blumenkopf, Swanson, and Larsen 1981.)

SECTION II. NATURE AND GENERAL CAUSES OF MOTOR IMPAIRMENTS AND ORTHOPEDIC DISABILITIES

In order to give the instructor a realistic perspective on the variety of MIOD disabilities, brief descriptions of the major MIOD disabilities are provided in this section. In addition to neurological and orthopedic disabilities, some chronic health problems are also considered.

The Major Neurological Disabilities

Neurological disabilities are those in which there is permanent damage to the central nervous system.

Traumatic spinal cord injuries (Foster et al., 1977) result when the spinal cord is partically or completely severed. Such injuries are permanent. The location and extent of the damage determines the magnitude of the paralysis. If damage to the spinal cord occurs in the back area, partial or total paralysis of the trunk and legs results. This condition is called paraplegia. If damage occurs in the neck area, partial or total paralysis of both arms/hands and the trunk and legs results. This is termed quadriplegia. Characteristics of spinal cord injury can include the inability to walk, the loss of hand dexterity, bowel and bladder dysfunction, and sensation impairment.

Cerebral palsy (CP) is a syndrome (a set of symptoms which occur together) that affects movement and posture and may be accompanied by language problems, seizures, mental retardation, and disorders of vision, hearing, other modes of perception, and speech (Foster et al. 1977). Because impairment may range from simply an awkward walk to severe life dysfunctions, it is extremely important to develop an assessment of life functions. Cerebral palsy generally results from an insufficient supply of oxygen to the brain before, during, or immediately after birth (Foster et al. 1977). There are also several other causes of CP. Cerebral palsy is commonly classified and described in three general forms (after Telford and Sawrey, 1967).

a) Spastic—characterized by jerky, spasmodic movements.
b) Athetoid—characterized by rhythmical, writhing movements.
c) Ataxic—characterized by disorder in balance.

Spina bifida is a congenital defect. Spina bifida occurs during embryo development. The vertebral column fails to completely enclose the spinal cord. In some cases this results in a protruding sac that may contain cerebrospinal fluid or even parts of the vertebral column. Spina bifida is frequently accompanied by hydrocephalus or meningitis, which can result in mental retardation (Greer et al., 1980). Foster et al. (1977) state that the limitations of the student with spina bifida can range from weakness and reduced sensation in the feet to a total lack of sensation and movement below the waist. Therefore, some individuals will require braces and crutches and some will use a wheelchair most of the time. There are three general categories of spina bifida (after Greer et al., 1980).

a) Spina occulta—This is the mildest form of spina bifida, and generally there is no neurological impairment or protrusion of the spinal cord.

b) Meningocele—This condition occurs when there is an opening in the vertebral column with a sac containing cerebrospinal fluid (but without nerve tissue) protruding through the opening.

c) Myelomeningocele—This condition occurs when parts of the vertebral column (and hence nerve tissue), are contained within the sac that protrudes through the opening. This latter form is the most debilitating type of spinal bifida.

Epilepsy is not a disease, but a malfunction in the electrical pathways in the neurons (nerve cells) of the brain. Epileptic seizures are a result of these neuro-electrical irregularities in the brain neurons. Anti-convulsant medication can either completely or partially control seizures in approximately 80 percent of the epileptic individuals (Foster et al., 1977).

A major problem with epileptic students whose seizures are not completely controlled by medication is the nonpredictability of the occurrence of seizures. Golden and Margolin (1975) point out that most other handicapped people have a constant opportunity to adapt to their disability, but that the person with epilepsy not controlled by medication may function normally one minute and be in a seizure the next. Greer et al. (1980) describe four major types of seizures.[1]

a) A Grand Mal seizure is a major motor seizure that lasts from 30 seconds to six minutes. An "aura" such as a particular feeling or odor sometimes warns the individual with epilepsy of an impending seizure. During the seizure the person may thrash around, lose bladder and/or bowel control, vomit, and/or breathe heavily. It is important to remove from the vicinity of the person experiencing a seizure any objects that might cause injury and one should not put anything in the person's mouth. If the seizure should continue beyond about six minutes, medical attention should be summoned. After an individual has such a seizure, he may be lethargic and confused for several minutes or hours.

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[1] A proposal on a revised clinical and electroencephalographic classification of epileptic seizures is given by the Commission on Classification and Terminology of the International League Against Epilepsy. Epilepsia, 22 (1981) 489-501 (Raven Press, NY).

b) A Petit Mal seizure is a mild type of seizure which usually occurs more frequently than grand mal seizures. The petit mal seizure is characterized by momentary and frequently unnoticed loss of consciousness accompanied by rapid blinking, a vacant stare, the dropping of an object, etc. Foster et al. (1977) point out (following the Guide to the Epilepsies) that teachers often mistake a petit mal seizure for day-dreaming and that teachers should be aware of the characteristics of such a seizure.

c) A Jacksonian seizure is a seizure that begins with involuntary twitching in one part of the body but which may progress throughout the entire body into a grand mal type of seizure. This form of epilepsy appears more frequently in adults than children. This type of seizure is also called Status Epilepticus.

d) A Psychomotor seizure is characterized by the person being in a trancelike condition, but yet displaying unusual behavior such as facial contortions, mumbling, violent movements, or robotlike movements. These seizures may last from only a few minutes to several days. As with the Jacksonian form, this epilepsy is not common in children. Foster et al. (1977) note that instructors frequently mistake these seizures for misbehavior.

Poliomyelitis (or "polio") is a viral disease, rarely encountered today in students, that attacks the tissue in the spinal cord. The individual is often paralyzed for life, thus requiring orthopedic appliances, surgery, and long-term medical care (Greer et al., 1980). This disease is not progressive, and treatment, although it often takes many years, may increase residual functions considerably (Love and Walthall, 1977). In that the polio virus affects only the neuromuscular system, it does not affect intelligence, speech, sensations, and bowel and bladder control (Calhoun and Hawisher, 1979, as adapted from Bleck and Nagel, 1975).

Multiple Sclerosis is a disease of unknown cause characterized by slow, progressive degeneration of the central nervous system. It may cause visual disturbances, weakness/paralysis, difficulties with bladder control, or mild emotional responses.

Hereditary Ataxias are a group of conditions characterized by non-coordinated muscular action, particularly when voluntary movements are attempted. Approximately 18 such conditions exist (McKusick, 1978) all of which follow simple predictable single-gene inheritance patterns. In addition, there are about 15 related conditions which do not appear to follow a simple inheritance pattern but nevertheless are probably at least partially caused by genetic factors (McKusick, 1978).

Major Orthopedic Disabilities

Orthopedic conditions are those involving defects in bones and/or muscles. The major orthopedic disabilities are described below:

Muscular Dystrophy is, as defined by the Muscular Dystrophy Association, the general designation for a group of chronic diseases whose most prominent characteristic is the progressive degeneration of the skeletal or voluntary musculature. They are, for the most part, hereditary conditions although spontaneous occurrence, as the result of genetic mutation, is not uncommon (Foster et al., 1977; McKusick, 1978).

Foster et al. (1977) also describe the three major types of muscular dystrophy affecting high-school age students as: 1) Pseudohypertrophic (Duchenne), which generally begins between the ages of two and six; 2) Facio-scapulo-humeral (Landouzy-Dejerine), in which the onset is usually in early adolescence; and 3) limb girdle (including Juvenile Dystrophy of Erb), which may begin anywhere in the first to third decades of life. These authors emphasize that mental deterioration does not occur with muscular deterioration, and it is important that these students be treated "as similarly as possible to the way non-disabled children are treated."

Rheumatoid arthritis is characterized by severe pain which is a result of inflammation and swelling in the joints and connective tissue (Greer et al., 1980). Calhoun and Hawisher (1979) state that while the disease may begin as early as six months of age, it stops in about two-thirds of the children by 10 years of age; however, permanent, destructive bone alterations may have occurred by this time.

Amputation is the removal of any of the limbs. Amputation causes significant changes in lifestyle, but the educational mitigative strategies and life function limitations are quite similar to those of intact MIOD individuals who have minimal or no use of their limbs due to other causes.

Chronic Health Problems

There are a variety of chronic diseases that may not require special teaching strategies, but may require the teacher to spend extra time with the student to make up work missed due to disabilitiy-caused absenteeism. These diseases are:

Hemophilia—an inherited coagulation disorder characterized by excessive bleeding.

Diabetes—a disorder of the body in the production of insulin, thus the inability to use carbohydrates, resulting in excessive sugar in the blood and urine.

Sickle cell anemia—a condition characterized by sickle-shaped red blood cells which reduces oxygen transport in the body.

Cystic fibrosis—an inherited disease of the mucous glands throughout the body, characterized by pulmonary/respiratory disorders and chronic infections.

Asthma—a respiratory disease marked by labored breathing and coughing.

Leukemias—a group of cancers of the blood, characterized by a proliferation of white blood cells.

Rheumatic fever—an infectious disease frequently resulting in damage to the heart.

Congenital heart disease—deficiencies in the heart or circulatory system present from the time of birth.

Tuberculosis—a communicable disease usually affecting the respiratory system.

Osteogenesis imperfecta—an inherited abnormality of connective tissue that may affect various organs causing fragile bones, short stature, or hearing loss.

Scoliosis and Kyphosis—a disease of the spinal column characterized by a curvature of the spine.

SECTION III. GENERAL FACILITATIVE STRATEGIES FOR MIOD STUDENTS

This section presents general mitigative strategies and helpful hints for both teachers and MIOD students in the mainstream classroom. In addition, the following pages offer several general mitigative teaching strategies in order to adjust the educational environment or teaching style to facilitate the instruction and learning of the MIOD student. These strategies are suggestions that the teacher may apply or modify, as appropriate. These strategies may also enable teachers to devise their own mitigative teaching strategies.

It is the purpose of mitigative teaching strategies to neutralize the handicapping condition of the MIOD student, thereby allowing the student to function as completely as possible in the mainstream science classroom. In designing mitigative science teaching strategies for MIOD students, the instructor (or others) will need to assess the student's life function impairments (as explained in Section I) and determine which impairments will probably influence the education of the MIOD student. This assessment can be done through consultation with the student's previous instructors, the school's guidance counselor, the parents or a guardian, the school medical staff, and the student. An accurate identification of the instructional/learning needs of the MIOD student is often difficult, and it is often necessary to revise or replace some of the strategies either because they prove inappropriate or because the student progresses. Therefore, planning, implementing, applying mitigative strategies may initially take some extra time and require some innovation and patience. The identification of the instructional/learning needs can be further complicated if there are multiple impairments, thereby requiring combinations of mitigative teaching strategies.

A portion of the following is modified from the book entitled The College Student With a Disability: A Faculty Handbook, published by The President's Commission on the Employment of the Handicapped (1980).

General Mitigative Strategies for MIOD Students

- The MIOD student should have access to all learning resources. If a classroom or faculty office is inaccessible, it will be necessary to find an alternative classroom or office.
- If breaks between classes are short (10 minutes or less), the student who uses a wheelchair or walks with braces and/or crutches may regularly be late for his next class. Frequently, the student must wait for assistance in opening doors (unless electric doors are available), and maneuver along crowded pathways and corridors. It is appropriate to discuss the situation with the student having these problems and to seek solutions. A "buddy-system" where an able-bodied student opens doors, etc., has proven effective in some schools.
- If a class involves field work, ask the student to participate in the selection of modes of transportation and possibly the selection of sites. The school is required to provide accessible transportation for students who use wheelchairs.
- Classes taught in laboratory settings will usually require some modification of the MIOD student's work station. Considerations include increased under-the-counter knee clearance, lower working countertop height, reduced horizontal working area, and increased aisle widths, though perhaps for only one aisle (Blumenkopf, Swanson, and Larson, 1981). Working directly with the student on what needs to be done may be the best way to determine modifications to the laboratory work station. However, if a work station is modified in accordance with established accessibility standards (ANSI, 1981), then the station will be usable by most students in wheelchairs. There is also a ***Portable Science Station*** now available designed especially for wheelchair bound students. The station can be moved from laboratory to laboratory as needed.
- The MIOD student should be allowed to benefit from the laboratory work to the fullest extent. If the assistance of an aide is required, the MIOD student can give complete instructions to the aide—from what chemical to add and what type of test tube to use to where to dispose of used chemicals. The disabled student can learn virtually everything except the psychomotor manipulations of the equipment and materials.
- Remember that MIOD wheelchair students are not always confined to their wheelchairs. They often transfer to automobiles and to furniture. Some who primarily use wheelchairs can walk with the aid of canes, braces, crutches, or walkers for short distances. Using a wheelchair some of the time does not mean an individual is faking a disability. It may be a method of conserving energy or for moving about more quickly.
- Since the MIOD student may have social adjustment problems which "spill-over" into his classroom, laboratory, and field trip activities, it is imperative that the teacher, instructional assistants (aides), and other school personnel understand his situation and accept him as a student wishing to learn. The acceptance and understanding of the MIOD student by the teacher can have a great influence on his acceptance and understanding by his peers. At times, the teacher may have to go beyond his usual approach to teaching. For example, during a class discussion the teacher may need to specifically ask for the MIOD student's opinion. This will allow the student

an opportunity to be perceived by the other student's as a thinking individual.

- Most students who use wheelchairs will ask for assistance if they need it. Don't assume automatically that assistance is required. Offer assistance if you wish, but do not insist; accept a "no, thank you" graciously.
- When talking to a student in a wheelchair, sit down, kneel, or squat, if the conversation continues for more than a few minutes, in order to maintain the same eye level for good eye contact.
- MIOD students must have opportunities to communicate and, in many cases, the opportunities must be deliberately provided, since there is a tendency for isolation from peers. Further, the disability should not be used as an excuse for non-participation in all regularly assigned oral presentations.
- Many speech-impaired students will be hesitant about participating in activities that require speaking. Even if the student has adjusted to a speech impairment, new situations may aggravate old anxieties. It is important that self-expression be encouraged, but pressure to speak is not apt to be helpful. It is important to allow time for a speech-impaired student to express himself so that confidence can be gained. It is also important for the instructor to accept and respond to all appropriate attempts at communication. When speaking to a speech-impaired person, continue to talk naturally. Instructors should strongly resist the temptation to complete words or phrases for a speech-impaired person.
- For persons who cannot speak and who are otherwise physically disabled so that they cannot sign, write, or type, various communication aids are available. These aids may range from sophisticated electronic "speaking" machines activited by punching a keyboard with a ***head pointer*** or ***mouth wand,*** to a ***spelling board*** consisting of the alphabet and a few common words and phrases when the speech-impaired person points to the letters and words on the spelling board, an assistant or the teacher may then speak them out loud. Some devices provide a "ticker tape" print-out, or display the message on a calculator-like screen across which the letters move. With less portable devices, the message is displayed on a television screen.
- Depending on the severity of the impairment, various adaptive methods may be required for the speech-impaired student. Many of the adaptive methods suggested above will also be appropriate for the speech-impaired student. Some speech impaired students will require no adaptive methods at all, but most will need patience, encouragement, and an opportunity to develop self-confidence in an unfamiliar group.

General Mitigative Strategies for Students with Chronic Health Problems

There are a variety of chronic diseases that may result in a moderate to very considerable amount of student absenteeism. The teacher may need to spend extra time with the student to help make up missed classroom work or arrange for some home-bound activities. These diseases may also require some, though usually not extensive, mitigative strategies. The most common of these chronic diseases and their educational implications are presented below:

Hemophilia—While the student with hemophilia should avoid contact sports and sports involving excessive strain on joints, they should not be excluded from all physical activity. In fact, moderate exercise is necessary to protect the joints from severe bleeding (Foster et al., 1977).

Diabetes—In lower school grades the diabetic student may require midmorning snacks and frequent trips to the restroom. As the student becomes older, he will have developed a more regimented schedule, and the teacher will only need to be aware that the student is a diabetic in case of an insulin reaction (Love, 1978).

Sickle Cell Anemia—The student should be given a schedule that does not call for vigorous exercise. The student's parents or the medical personnel of the school should be notified in the event of discomfort or pain. Additional problems that may occur as a result of sickle cell anemia include (Calhoun and Hawisher, 1979):

a) delayed growth and puberty
b) urological problems
c) heart failure
d) stroke
d) severe limitations if bones and joints are affected

Cystic Fibrosis—This condition is not a communicable disease, but a congenital, inherited one. But because cystic fibrosis is a respiratory problem and feared by those not knowledgeable about its noncontagious nature, peer acceptance can be a serious problem. Also, since cystic fibrosis is a respiratory problem, the instructor should be aware that the student will fatigue more easily than other students (Love, 1978).

Asthma—During an asthma attack, the student will have difficulty breathing due to the closing of the small bronchioles of the lungs. The asthmatic student should be provided with the appropriate medicine (as determined previously) and given a chance to rest during and immediately following an attack (Love, 1978).

Rheumatic Fever—The student may have to miss school for long periods of time during convalescence. While the student's physical activity may have to be altered, reinfection is the problem of which the instructor should be most aware.

Congenital Heart disease—Symptoms that the teacher should be aware of in interacting with students who have heart disease include: shortness of breath, chest pain, faintness, rapid heart beat, and fatigue. The student will probably need to be limited in activities which require strenuous physical exertion. The student may also require shorter school days and periods of rest (Calhoun and Hawisher, 1979).

Leukemia—The educational implication of this type of cancer depends upon the seriousness of the disease If acute, the student's life expectation will be shorter than that of his non-affected peers, and he may require a homebound tutor as the disease progresses.

Tuberculosis—Tuberculosis is an infectious disease. Students with tuberculosis must therefore attend hospital schools in the early stages of the disease followed by some form of home instruction. After the disease has been arrested, the student can return to the regular classroom. Upon return to the regular classroom, students with tuberculosis of the bones or joints will need to avoid strenuous physical activities (Love, 1978).

Scoliosis and Kyphosis—Students with scoliosis or kyphosis may require a schedule of restricted mobility. They may wear a Milwaukee brace day and night, except while bathing and exercising, for about two years (or until the spine is positioned correctly). The brace is restrictive, and the student will not be able to sit in a conventional chair while wearing it (Calhoun and Hawisher, 1979).

Osteogensis Imperfecta—Students with "brittle bone disease" will need to avoid strenuous physical activities and may, in their early years, be susceptible to a high incidence of bone breaks and fractures (Calhoun and Hawisher, 1979). This condition usually persists into adulthood.

General Mitigative Strategies for Specific MIOD Disabilities

There are some general mitigative strategies that are unique to certain of the MIOD disabilities. We present these strategies here since they do not fit easily into the specific strategies of Section IV of this chapter.

Short Stature—Students of short stature will have in-classroom access problems similar to those of a student in a wheelchair. Additional problems involve seeing demonstrations, chalkboards, etc. Fatigue may also be encountered; hence some of the students may use a walker, cane, or crutches.

Epilepsy—The student with epilepsy will have little problem in the classroom. In most cases, seizures will be controlled by medication. A student with epilepsy will generally have learned to manage his seizure activity through adequate rest, proper diet, and regular medication. Most students with epilepsy will be able to participate in sports and lead active, normal lives.

Foster et al., (1977) offer the following suggestions to teachers of students with epilepsy:

a) Attend an information/sensitization program on epilepsy.
b) Know the type of seizures the student might have.
c) Know how to deal with the student's type of seizure.
d) Know the safety factors that should be considered.
e) Know the type of medication taken and its possible side effects.

Spina Bifida—Spina bifida is a frequent reason for an ostomy. The student with spina bifida may also have short stature and may use a wheelchair, braces, or crutches. Classroom modifications that may be required will depend on the student's life function limitations.

Muscular Dystrophy—Strategies for students with muscular dystrophy depend upon the severity of the condition. Foster et al. (1977) state that if the condition is mild, the student will have adequate independent living skills and will require no special instruction and modifications. However, if the condition is severe, the student will have acquired little physical independence. These students will require strategies similiar to those needed for students with the lack of, or minimal use of, their arms and legs.

Rheumatoid Arthritis—The student with rheumatoid arthritis has different needs than most other MIOD students. For instance, during periods of increasing pain, the teacher will need to be patient and allow more time for educational activities to be completed. Calhoun and Hawisher (1979) state that rheumatoid arthritis may interfere with school attendance and after-school activity. Physical endurance will probably also be affected. The disease may result in permanent deformities that may restrict mobility, thus making walking for any length of time very difficult. Further, during peaks of incidence, the student with arthritis may experience stiff, painful joints as well as fatigue--thereby, resulting in a "cranky" and sometimes hostile student.

Other Helpful Information on Mitigative Teaching Strategies

- Students use wheelchairs as a result of a variety of disabilities including spinal cord injury (quadriplegia and paraplegia), cerebral palsy, polio, multiple scelerosis, severe arthritis, amputation, muscular dystrophy, etc. Wheelchairs come in a variety of styles and sizes, and many types of optional attachments are available. Wheelchairs are either manual or electrically powered. Students who are unable to propel the chair themselves will use an aide or an electrically powered wheelchair. However, being assisted by an aide who pushes the chair creates a dependency on another person that most students prefer to avoid. Some of the standard accessories that student may add to their wheelchairs are special seat cushions (to prevent pressure sores, which result from long periods of sitting), *tote bags* that attach to the chair back or arms, and trays that fit over the arms of the chair to serve as a desk. Some wheelchairs are designed with desk arms that are lower in front, so the chair will fit under a regular-height desk or table.

- To a student with a wheelchair, the wheelchair is part of the persons' body space. Don't hang or lean on the chair—that would be similar to hanging or leaning on the person. Doing so is fine if you are good friends, but inappropriate otherwise.
- A student sitting in a wheelchair is only about as tall as most young children, and since a pat on the head is often used to express affection toward children, many people are inclined to reach out and pat the wheelchair student on the head. Such a gesture is patronizing and demeaning. Pat him on the back or shoulder instead.
- MIOD students must be given non-deliberate incidental learning opportunities, see sub-section 5 of Section II in the previous chapter.
- Learning and motivation of the MIOD student are improved by successful role models in the student's area of career interest. Further, some degree of success at the various tasks and educational experiences is extremely important for the MIOD student. The science teacher should be aware of these needs in planning the student's science experience.

Summary

There are a variety of mitigative strategies that may be employed by the teacher to "neutralize" MIOD and chronic health conditions. The general strategies included here are suggested as an overview to aid the teacher with the mainstreaming of these students.

After having made some form of life function impairment assessment, the teacher will be better prepared to select or devise effective mitigative teaching techniques and strategies. The teacher should consider that as the MIOD student progresses or as other conditions are revealed, the student may require additional or modified strategies.

SECTION IV. SPECIFIC MITIGATIVE STRATEGIES: THE REFERENCE TABLES

In order to select from Tables 10-16 the table that is appropriate for a particular student, you must generally categorize the impairment of the student, as discussed previously. Once the correct table has been selected, identify the relevant teaching method(s). The numbers listed under each method refer to mitigative teaching strategies (MTS) described in Table 17. If you cannot fully understand the strategies in Table 17, consult the glossary.

In compiling this series of tables, we recognized that the severity of the disability may affect the selection of the specific mitigative strategy(ies). Therefore, we have presented a set of alternative strategies, or techniques (when available) so that the instructor can work with the student in selecting the most appropriate strategy(ies) for neutralization of the specific student's handicap. The co-ordination between the student and the instructor in the choice of initial strategies is very critical. Moreover, it has the added benefit of making each appreciate the problems confronted by the other.

EXAMPLE

If an instructor wanted to know what to do to make a lecture more accessible and easier for an individual with only minimal arm and hand usage, he would refer to Table 13 (for that type of functional limitation) and then to the teaching method titled "Teacher Presentation." The numbers he would find under "Teacher Presentation" (1.01, 1.04, 2.01, 3.03, 3.04, and 4.02) refer to the list of Mitigative Teaching Strategies. Those strategies are given below:

1.01 Use of an ***amanuensis***
1.04 Arrange for note taker by peer with carbonless copy paper or supply a copy of the instructor's notes to the student.
2.01 Use a ***hand saddle*** for pencil or pen.
3.03 Use a ***wheelchair lap board.***
3.04 Use a tape recorder.
4.02 Allow more time for the student to complete the activities.

TABLE 10. INSTRUCTIONAL METHODS AND POSSIBLE MITIGATIVE TEACHING STRATEGIES (MTS) FOR STUDENTS WITH CERTAIN NEUROLOGICAL DISABILITIES (those students who are highly distracted)

TEACHING METHOD: **TEACHER PRESENTATION** (lecture)[1]

MTS: 4.03, 5.05, 5.06

TEACHING METHOD: **ACTIVE AND PASSIVE LABORATORIES**

MTS: 4.03, 4.06, 5.05, 5.06

TEACHING METHOD: **ACTIVE AND PASSIVE FIELD TRIPS**

MTS: 4.03, 5.05, 5.06

TEACHING METHOD: **READING**

MTS: 4.03, 5.05, 5.06

TEACHING METHOD: **GROUP INTERACTION AND DISCUSSION**

MTS: 4.03, 5.05, 5.06

TEACHING METHOD: **AV/TACTILE**[2]

MTS: 4.03, 5.05, 5.06

TEACHING METHOD: **RESEARCH PROBLEM**[3]

MTS: 4.03, 5.05, 5.06

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[1] This is assuming that there will be little or no discussion. If discussion and question are used, refer to the section on group interaction and discussion.

[2] This teaching method may be used to supplement other teaching methods.

[3] The research problem may also include strategies from all other teaching methods.

TABLE 11. INSTRUCTIONAL METHODS AND POSSIBLE MITIGATIVE TEACHING STRATEGIES (MTS) FOR STUDENTS WITH LACK OF, OR MINIMAL USE OF, LEGS

TEACHING METHOD: **TEACHING PRESENTATION** (lecture)[1]

MTS: 3.03

TEACHING METHOD: **ACTIVE AND PASSIVE LABORATORIES**

MTS: 3.03, 3.08, 3.14, 3.15, 3.16, 3.21, 3.25, 4.05, 4.06, 4.07, 5.01, 5.03, 5.07, 5.10, 5.12, 5.13

TEACHING METHOD: **ACTIVE AND PASSIVE FIELD TRIPS**

MTS: 1.02, 1.03, 1.05, 3.03, 3.08, 3.14, 3.21, 3.26, 4.05, 4.09, 4.10, 4.11, 5.01, 5.07, 5.11, 6.04

TEACHING METHOD: **READING**

MTS: None

TEACHING METHOD: **GROUP INTERACTION AND DISCUSSION**

MTS: 4.11, 5.01, 5.02, 5.07

TEACHING METHOD: **AV/TACTILE**[2]

MTS: None

TEACHING METHOD: **RESEARCH PROBLEM**[3]

MTS: 1.02, 1.05, 3.08, 5.01, 5.07, 5.11

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[1] This is assuming that there will be little or no discussion. If discussion and question are used, refer to the section on group interaction and discussion.

[2] This teaching method may be used to supplement other teaching methods.

[3] The research problem may also include strategies from all other teaching methods.

TABLE 12. INSTRUCTIONAL METHODS AND POSSIBLE MITIGATIVE TEACHING STRATEGIES (MTS) FOR STUDENTS WHO ARE NON-VERBAL OR HAVE SPEECH DEFECTS

TEACHING METHOD: **TEACHER PRESENTATION** (lecture)[1]

MTS:6.01, 6.03

TEACHING METHOD:**ACTIVE AND PASSIVE LABORATORIES**

MTS: 3.01, 3.02, 3.05, 3.10, 3.13, 3.24, 4.02, 4.06, 6.01, 6.02, 6.03

TEACHING METHOD: **ACTIVE AND PASSIVE FIELD TRIPS**

MTS: 3.01, 3.02, 3.05, 3.10, 3.13, 4.02, 6.01, 6.02, 6.03

TEACHING METHOD: **READING**

MTS: 6.01, 6.03

TEACHING METHOD: **GROUP INTERACTION AND DISCUSSION**

MTS: 3.01, 3.02, 3.05, 3.10, 3.13, 4.02, 4.11, 6.01, 6.03

TEACHING METHOD: **AV/TACTILE**[2]

MTS: 6.01, 6.03

TEACHING METHOD: **RESEARCH PROBLEM**[3]

MTS: 3.24, 6.01, 6.03

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[1] This is assuming that there will be little or no discussion. If discussion and questions are used, refer to the section on group interaction and discussion.

[2] This teaching method may be used to supplement other teaching methods.

[3] The research problem may also include strategies from all other teaching methods.

TABLE 13. INSTRUCTIONAL METHODS AND POSSIBLE MITIGATIVE TEACHING STRATEGIES (MTS) FOR STUDENTS WITH A LACK OF, OR MINIMAL USE OF, ARMS AND/OR HANDS

TEACHING METHOD: **TEACHER PRESENTATION** (lecture)[1]

MTS: 1.01, 1.04, 2.01, 2.02, 3.03, 3.04, 4.02

TEACHING METHOD: **ACTIVE AND PASSIVE LABORATORIES**

MTS: 1.01, 1.03, 2.01, 2.02, 3.04, 3.08, 3.11, 3.12, 3.17, 3.18, 3.19, 3.20, 3.21, 3.22, 3.25, 4.01, 4.02, 4.05, 4.06, 4.08, 5.08, 5.09, 5.13, 6.02

TEACHING METHOD: **ACTIVE AND PASSIVE FIELD TRIPS**

MTS: 1.01, 1.03, 1.06, 2.01, 2.02, 2.03, 3.04, 3.06, 3.08, 3.20, 3.21, 4.01, 4.02, 4.03, 4.05, 4.08, 4.09, 6.02, 6.04

TEACHING METHOD: **READING**

MTS: 1.01, 3.04, 3.22, 3.23, 3.25, 4.02

TEACHING METHOD: **GROUP INTERACTION AND DISCUSSION**

MTS: 4.11

TEACHING METHOD: **AV/TACTILE**[2]

MTS: 1.01, 1.04, 2.01, 3.04, 4.02

TEACHING METHOD: **RESEARCH PROBLEM**[3]

MTS: 1.01, 1.04, 2.01, 2.02, 2.03, 3.04, 3.08, 4.02, 4.08

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[1] This is assuming that there will be little or no discussion. If discussion and questions are used, refer to the section on group interaction and discussion.

[2] The teaching method may be used to supplement other teaching methods.

[3] The research problem may also include strategies from all other teaching methods.

TABLE 14. INSTRUCTIONAL METHODS AND POSSIBLE MITIGATIVE TEACHING STRATEGIES (MTS) FOR STUDENTS WITH RESTRICTED JOINT MOBILITY (e.g., Rheumatoid Arthritis)

TEACHING METHOD: **TEACHER PRESENTATION** (lecture)[1]

MTS: 1.01, 1.04, 3.04, 4.02, 4.03, 4.04

TEACHING METHOD: **ACTIVE AND PASSIVE LABORATORIES**

MTS: 1.01, 1.02, 1.03, 1.05, 3.04, 3.06, 3.08, 3.19, 3.20, 3.21, 3.25, 4.01, 4.02, 4.04, 4.05, 4.06, 5.09, 5.10, 5.13, 6.02

TEACHING METHOD: **ACTIVE AND PASSIVE FIELD TRIPS**

MTS: 1.01, 1.02, 1.03, 1.05, 2.02, 3.04, 3.06, 3.08, 4.01, 4.02, 4.08, 4.09, 5.10, 6.02, 6.04

TEACHING METHOD: **READING**

MTS: 1.01, 1.04, 3.04, 3.22, 3.23, 3.25, 4.02

TEACHING METHOD: **GROUP INTERACTION AND DISCUSSION**

MTS: 4.11, 5.10

TEACHING METHOD: **AV/TACTILE**[2]

MTS: 1.01, 1.03, 3.04, 4.02, 5.10

TEACHING METHOD: **RESEARCH PROBLEM**[3]

MTS: 1.01, 2.01, 2.02, 3.04, 3.08, 4.02, 4.08

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[1] This is assuming that there will be little or no discussion. If discussion and questions are used, refer to the section on group interaction and discussion.

[2] This teaching method may be used to supplement other teaching methods.

[3] The research problem may also include strategies from all other teaching methods.

TABLE 15. INSTRUCTIONAL METHODS AND POSSIBLE MITIGATIVE TEACHING STRATEGIES (MTS) FOR STUDENTS WITH LATERAL SPINE CURVATURE (SCOLIOSIS), DWARFISM (OR SHORT STATURE).

TEACHING METHOD: **TEACHER PRESENTATION (lecture)**[1]

MTS: 5.04

TEACHING METHOD: **ACTIVE AND PASSIVE LABORATORIES**

MTS: 4.06, 5.04, 5.10, 5.13

TEACHING METHOD: **ACTIVE AND PASSIVE FIELD TRIPS**

MTS: 4.03, 4.09, 5.04, 5.10

TEACHING METHOD: **READING**

MTS: 5.04

TEACHING METHOD: **GROUP INTERACTION AND DISCUSSION**

MTS: 4.11, 5.10

TEACHING METHOD: **AV/TACTILE**[2]

MTS: 5.04, 5.10

TEACHING METHOD: **RESEARCH PROBLEM**[3]

MTS: 5.04

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[1] This is assuming that there will be little or no discussion. If discussion and questions are used, refer to the section on group interaction and discussion.

[2] This teaching method may be used to supplement other teaching methods.

[3] The research problem may also include strategies from all other teaching methods.

TABLE 16. INSTRUCTIONAL METHODS AND POSSIBLE MITIGATIVE TEACHING STRATEGIES (MTS) FOR STUDENTS WITH LACK OF, OR MINIMAL USE OF, ARMS AND LEGS

TEACHING METHOD: **TEACHER PRESENTATION** (lecture)[1]

MTS: 1.01, 1.02, 1.04, 2.01, 3.03, 3.04, 4.02

TEACHING METHOD: **ACTIVE AND PASSIVE LABORATORIES**

MTS: 1.01, 1.02, 1.03, 1.04, 1.06, 2.01, 2.02, 2.03, 3.03, 3.04, 3.06, 3.08, 3.11, 3.12, 3.14, 3.15, 3.16, 3.17, 3.18, 3.19, 3.20, 3.21, 3.22, 4.01, 4.02, 4.05, 4.06, 4.07, 4.08, 4.10, 5.01, 5.03, 5.07, 5.08, 5.09, 5.10, 5.12, 6.02

TEACHING METHOD: **ACTIVE AND PASSIVE FIELD TRIPS**

MTS: 1.01, 1.02, 1.03, 1.05, 1.06, 2.01, 2.02, 2.03, 3.03, 3.04, 3.06, 3.08, 3.14, 3.20, 3.21, 4.01, 4.02, 4.05, 5.01, 5.07, 6.02

TEACHING METHOD: **READING**

MTS: 1.01, 3.04, 3.22, 3.24, 3.25, 4.02

TEACHING METHOD: **GROUP INTERACTION AND DISCUSSION**

MTS: 4.11, 5.01, 5.02, 5.07

TEACHING METHOD: **AV/TACTILE**[2]

MTS: 1.01, 1.04, 2.01, 3.03, 3.04, 4.02

TEACHING METHOD: **RESEARCH PROBLEM**[3]

MTS: 1.01, 1.02, 1.04, 1.05, 2.01, 2.02, 2.03, 3.03, 3.04, 3.08, 4.02, 5.01, 5.07

---

[1] This is assuming that there will be little or no discussion. If discussion and questions are used, refer to the section on group interaction and discussion.

[2] This teaching method may be used to supplement other teaching methods.

[3] The research problem may also include strategies from all other teaching methods.

TABLE 17. MITIGATIVE STRATEGIES FOR MIOD STUDENTS

1.0 **ASSISTANCE FROM OTHER PEOPLE**

1.01 Use an ***amanuensis.***
1.02 Use a wheelchair pusher.
1.03 Use a ***peer-buddy system.***
1.04 Arrange for notetaking by a peer with carbonless copy paper (available from local printers) or supply a copy of the instructor's notes to the student.
1.05 Provide for assistance in transfer to and from wheelchair.
1.06 Provide for assistance with personal needs (and perhaps more time).

2.01 **PROSTHESIS**[1]

2.01 Use a ***hand saddle*** (or other writing prosthesis) for pencil or pen.
2.02 Use a ***hand or head pointer*** for typewriter (Calhoun and Hawisher, 1979).
2.03 Use an extension arm aid (Calhoun and Hawisher, 1979).

3.0 **MECHANICAL (TECHNICAL)**

3.01 Use a ***voice synthesizer.***
3.02 Use the ***Blissymbol system.***
3.03 Use a wheelchair ***lap board*** (could also have alphabet and use pointer).
3.04 Use a tape recorder (also for use if writing is difficult).
3.05 Use a ***manual language or alphabet board.***
3.06 Use a ***minicomputer.***
3.07 Use a ***magnetic card machine*** (Calhoun and Hawisher, 1979).
3.08 Use a ***modified typewriter*** (Calhoun and Hawisher, 1979).
3.09 Use a ***System 80*** (Calhoun and Hawisher, 1979).
3.10 Use a ***talking board.***
3.11 Use a ***microprocessor*** (robotic arms for quadriplegic).
3.12 Use a ***vacuum pickup system*** (quadriplegics can manipulate small items such as money).
3.13 Use a ***speaking computer*** (Artificial Language Laboratory, Michigan State University).
3.14 Use a ***wheelchair with variable elevation control.***
3.15 Use a ***pivoting mirror*** above a demonstration on table (Foster et al., 1977).
3.16 Use a videotape and/or closed-circuit television system.
3.17 Use an overhead projector.
3.18 Use electric hot plates instead of bunsen burners as heat source.
3.19 Increase size of wheels, dials, handles and buttons on equipment.
3.20 Use modified lids on tops of containers (wide/bigger).
3.21 Use "***Reachers***" for materials and items located in high or low places.
3.22 Use a page turner (Calhoun and Hawisher, 1979).
3.23 Use small sections of large texts or readings.
3.24 Use a typewriter.
3.25 Use easels, portable reading racks, a standing table, and adjustable seats and desks.
3.26 Use backpack that fits on wheelchair.

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[1] While artificial limbs and the wide variety of standard assistive prothetic devices are not included here, they may be quite useful and in most cases necessary.

4.0 TEACHER STRATEGIES

4.01 Select non-manual types of teaching techniques.[1]
4.02 Allow more time for the student to complete the activities.
4.03 Reduce the amount of activity or shorten the activity time.
4.04 Provide breaks for stretching.
4.05 Store materials so as to be accessible to all.
4.06 Enforce wearing of laboratory aprons and goggles.
4.07 Use portable eye wash and/or water rinse for toxic chemical spills.
4.08 Provide means for recording of data, charts, or graphs (if amanuensis is not otherwise required).
4.09 Make special arrangements with curator during passive field trips.
4.10 Be aware of and prevent possible overheating of student with poor heat regulation.
4.11 Include student in open discussions.

5.0 ARCHITECTURAL FACILITIES[2]

5.01 Facilitate access to wheelchair.
5.02 Lower chalkboard and/or corkboard.
5.03 Install chalkboard and/or corkboard 3" to 6" from the edge of the wall (so student(s) can lean or steady themselves with the wall).
5.04 Alter the height of tables to "fit" students.
5.05 Lower lighting levels.
5.06 Remove distractive visualization (visual pollution).
5.07 Use non-skid floor for students who use crutches and wheelchairs.
5.08 Place water, gas, and electric facilities in accessible location (Foster et al., 1977).
5.09 Use low-force electric microswitches for lights and equipment.
5.10 Use ramps and raised platforms for students' access.
5.11 Use a ramped, or power lift, van for transportation to and from activity.
5.12 Use classroom sinks that are accessible from 3 sides.
5.13 Use adjustable height tables.

6.0 STUDENT STRATEGIES[3]

6.01 Acknowledge understanding by blinking, head nodding, or pointer.
6.02 Use oral presentation or response.
6.03 Use written communications.
6.04 Use health supportive devices (such as urine bag) during field trips.

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[1] For example, more oral presentations instead of written or the use of a vacuum pump for pipette suction.

[2] There are many guides to overall facility accessibility specifically, ANSI, 1981. We cannot cover here the full range of necessary changes in facilities, but this reference gives the critical needs on facility accessibility.

[3] There is a wide array of specific prostheses that many students have to facilitate their education, but because of space cannot be listed here.

GLOSSARY

Acoustic Compass - an electronic device for blind students used to determine direction. A tone differential is used to indicate if the individual, vehicle, or boat is off-course.

Alphabet board - a board used for non-vocal communication with the alphabet (and/or words) enscribed. The non-vocal individual points to a letter or words for communication.

Amanuensis - an assistant with secretary-like duties for disabled individuals, but this person may do other non-secretarial tasks like reading test questions, writing answers, etc.

Apollo System - see CCTV.

Aud-A-Mometer - an electronic device for visually impaired students which is used to determine temperature. A tone is balanced to zero (no sound) and reads temperature on a braille scale. Available from Science for the Blind, Inc.

Audicator - an electronic indicator for measuring liquids (Ricker and Benefield, 1981).

Audio Trainer - an FM broadcast/receiver system worn by both instructor and by the student with a hearing aid. (Telex Communications has one such unit).

Audition FM Unit - similar to and performs the same function as an audio trainer.

Auditory Stimuli - sound stimuli.

Blind Spot - that part of the retina where the optic nerve pierces the eyeball.

Blissymbols - a system of symbology used by non-verbal students in communication.

Braille - a system of six raised dots on paper, plastic, or metal which represents alphabetic, numeric, or contractions of information. See the last page of this text for examples.

Braille Computer Terminal - a terminal that, when connected to a computer, can produce output (information) in braille.

Braille Clocks - regular clocks with open or opening faces which have the hours marked with raised dots.

Braille Slide Rule - a slide rule using raised dots to indicate the numbers.

Braille Stopwatch - a stopwatch with an opening face with raised dots to indicate the time lapse by tactile means.

Braille Wristwatch - similar to a braille stopwatch only it is a wrist watch.

Braille Writer - a mechanical device, like a typewriter, with 9 keys which produces braille output on heavy paper. See Perkins braille writer.

Carbonless Copy Paper - sometimes called "NCR" paper after the original producer. These papers produce copies of writings from impressions similar to carbon paper, only no carbon paper is used. Available from local print shops.

Cassette Braille - braille coding on a tape which, when processed, will produce readable braille.

Cataract Glasses - glasses with lenses designed to compensate for the removal of the normal eye lenses due to cataracts (clouding or opacity of the lens).

Central Vision - that part of the field of vision which involves the central area of the retina.

Cerebral Cortex - the external layer of the brain that is highly convoluted which controls motor skills and sensory processes.

Closed-Circuit Television Magnifer (CCTV) - a television camera which can be focused on an object, or print, to be viewed. An enlarged image is displayed on a television screen for viewing. The degree of enlargement is generally adjustable by the user. (Visualtek and Apollo are common CCTV magnifer systems.)

Compressed Speech - an electronically processed tape recording in which pauses and gaps have been removed.

Corneal Cataract Lenses - those corrective lenses which correct lens damage due to cataracts.

CRT Terminals - Cathode ray tube terminals are those which exhibit the output from a computer on a tube similar, or identical, to the picture tube of a television set.

Decibel - a unit used for measuring the volume of sound.

Dog Guides - a dog which is specifically trained to assist a blind person, particularly for mobility purposes (sometimes called guide dogs).

Electric Braille Writer - an electro-mechanical device which produces braille impressions on heavy paper. See Braillewriter.

Graphing Board - several types are available which allows the blind student to graph (with pins or tacks) field or experimental results on a cork, rubber, or other soft material board which is pre-scored with co-ordinate graph lines which are raised.

Hand Saddle - a device of leather, wood, metal or plastic which allows an individual with limited hand control to hold a pencil, pen, or other writing device.

Head Pointer - a stick attached to the head by a small harness which allows a quadriplegic non-vocal individual to point to alphabetic letters or symbols on a lap or wheelchair board. Such a device can also be used by quadriplegic individuals to operate electronic equipment or electromechanical devices.

Hertz - a unit of frequency of a periodic process equal to one cycle per second. Used to measure sound pitch. For example, a base drum would generate low sound frequencies, a whistle would generate very high sound frequencies.

Individual Educational Programs - annual individual educational plans for students jointly approved by teachers, evaluators, and parents for the long term education of the student. Usually used at the elementary, junior high, middle school, and secondary levels. Ages covered are from 3 to 23 years.

Intra-ocular Lenses - plastic lenses that are implanted into the eye.

Lap Board - a board attached to a wheelchair which covers the lap of a wheelchair bound individual. It may also contain the alphabet, numbers, and words for communication by a wheelchair bound speech impaired individual.

Large Print Books - books in which large type is used. Large type is about 18 points (about 1/4 inch in height) whereas regular 10 point print, such as this, is about 1/8 inch in height.

Large Print Typewriter - a typewriter that is designed to produce large print type.

Laser Cane - a laser electronic device used for assisting a blind person in ambulation.

Light Sensor - A device that converts light energy into electrical energy that can then be converted into sound for use by the blind with certain equipment.

Manual Language - a system of finger, knuckle, and hand positions along with associated movements which is used as a means of communication among deaf individuals or among deaf and hearing individuals.

Melanin - the pigment of the skin.

Microprocessor - similar to a microcomputer, but with greater storage and processing capabilities.

Milwaukee Brace - a body brace used to correct spine curvature.

Minicomputer - an electronic device capable of "directing" certain functions to be performed by electro-mechanical means.

Modified Typewriter - many forms of modifications of typewriters exist as adapted to an individual's specific life function limitation e.g., single-handed typewriters.

Mouth Wand - serves the same function as a head pointer only it is held in the mouth.

Nemath Code - a system of six raised dots on paper, plastic, or metal which represent numbers and mathematical symbology, more or less, a sub-set of braille.

Ohaus-Cent-O-Gram Balance - a laboratory balance manufactured by the Ohaus Scale Corporation to which an auditory output device can be attached for use by blind individuals.

Olfactory Stimuli - regarding stimulating the sense of smell.

Paperless Braille Machines - Braille is recorded and stored on regular magnetic cassette tapes. When played back, the braille is displayed one line at a time. The braille pins on the display board, are activated by the playing of the magnetic tape.

Pathsounder - a sonic device for use by blind individuals which aids in ambulation.

Peer-Buddy System - a system wherein non-handicapped students would assist handicapped students in a variety of scholastic, or other, tasks.

Peripheral Vision - the outer part of the field of vision; specifically: the part that lies more than 30° from the line of sight.

Perkins Braille Writer - a common braille writer used to produce braille materials. It has nine keys, six keys make the six dots in a braille cell; a backspace key, a forward advance key, and a line advance key are the other three keys.

Pharynx - the throat.

Pivoting Mirror - a mirror, with or without an electromechanical device, which can rotate to allow an individual who cannot bend over or around an exhibit, or experiment, but can observe the activity via an adjustable mirror.

Portable Science Station - a slightly elevated laboratory bench on wheels (for a wheelchair to easily roll under). Included in the system is water, electric, vacuum, air, apparatus rod, electric burner (or propane burner), and variable voltage unit. Available from Fisher Scientific (Pittsburgh) or Conco Industries, West Haven, Conn.

Pro-Pipette - a rubber bladder suction apparatus for use in titrations or with pipettes. No mouth suction is needed. It is operated by inflation and deflation of the bladder (available from Fisher Scientific, Pittsburgh).

Raised-Dot Barometer - a standard barometer with raised dots for reading the barometric pressure.

Raised Line Drawings - diagrams that can be read tactilely with the fingertips.

Reachers - mechanical devices which allow individuals of short stature, in wheelchairs, or with joint or muscle problems to obtain items either above or below their level of reach.

Reading Machines - see entries on Kurzweil and Optacon machines (page 15).

Relief Maps - maps on which the features are raised so they can be tactilely read with the fingertips.

Re-pipette - a version of the pro-pipette.

Re-pipette Jr. - a version of the pro-pipette.

Sewell Raised Line Drawing Kit - a soft plastic rubber-like clipboard on which materials like transparent plastic sheets are placed and a scriber (like a ball point pen with no ink) is used to make raised drawings which blind students can read with their fingertips.

Sighted Guide - a person with vision who serves as a guide for a visually impaired person.

Sonicguide - an apparatus using sonic beams to assist blind individuals to ambulate. Altered pitch indicates objects in the path of the sonic scan.

Speaking Computer - a large version of the talking calculator, but can have considerably greater capabilities.

Speech-Time Compressors - a device used with recorders to play back a tape at a faster rate without causing a "Donald Duck" voice effect. This reduces the amount of time it takes a person (who has to rely on tapes) to listen to taped materials.

Spelling Board - a board with the alphabet inscribed, painted, or printed thereon where a non-verbal quadriplegic individual can use a mouth wand or head pointer or his finger to communicate information. Sometimes incorporated into a lap or wheelchair board.

Tactile Models - models that are observed by using the fingertips.

Tactile Skills - those touch or feeling skills, usually involving the tips of the fingers, which blind students use to "read" braille, models, raised diagrams, thermoforms, or other materials.

Tactile Stimuli - stimuli that are read with the hands or fingertips.

Talking Board - this device is available in several forms, but essentially allows the non-verbal individual with or without severe arm limitations to communicate with a voice synthesizer (speaking computer).

Talking Calculator - a hand calculator with the capability of producing an oral synthesized output for the visually impaired student.

Talking Terminals - computer terminals with oral synthesized outputs.

Thermoform - a plastic sheet on which has been imprinted (raised lines or braille) information. Ink printing may also be used. The last page of this book is an example of a thermoform.

Three Dimensional models - models that simulate characteristics of real objects in three dimensions.

Tote Bags - knapsack-like bags used to carry books and other items usually attached to the back of a wheelchair. Can also be used like a knapsack.

Vacuum Pick-up System - an electromechanical device which allows an individual with severe arm and hand limitations to pick-up and manipulate paper money and other papers.

Visualtek - see CCTV.

Voice Synthesizer - an electronic device which converts mechanical manipulation into simulated vocal sounds.

Voice Synthesizer Thermometer - a thermometer that has the capability of producing the temperature reading in oral synthesized speech.

Wheelchair Lap Board - very similar to a spelling board, but is usually attached to a wheelchair and is removeable.

Wheelchair with Variable Elevation Control - this wheelchair is fitted with electromechanical devices and controls with allow for the seat portion of the chair to be raised or lowered (Brindle, I. 1981).

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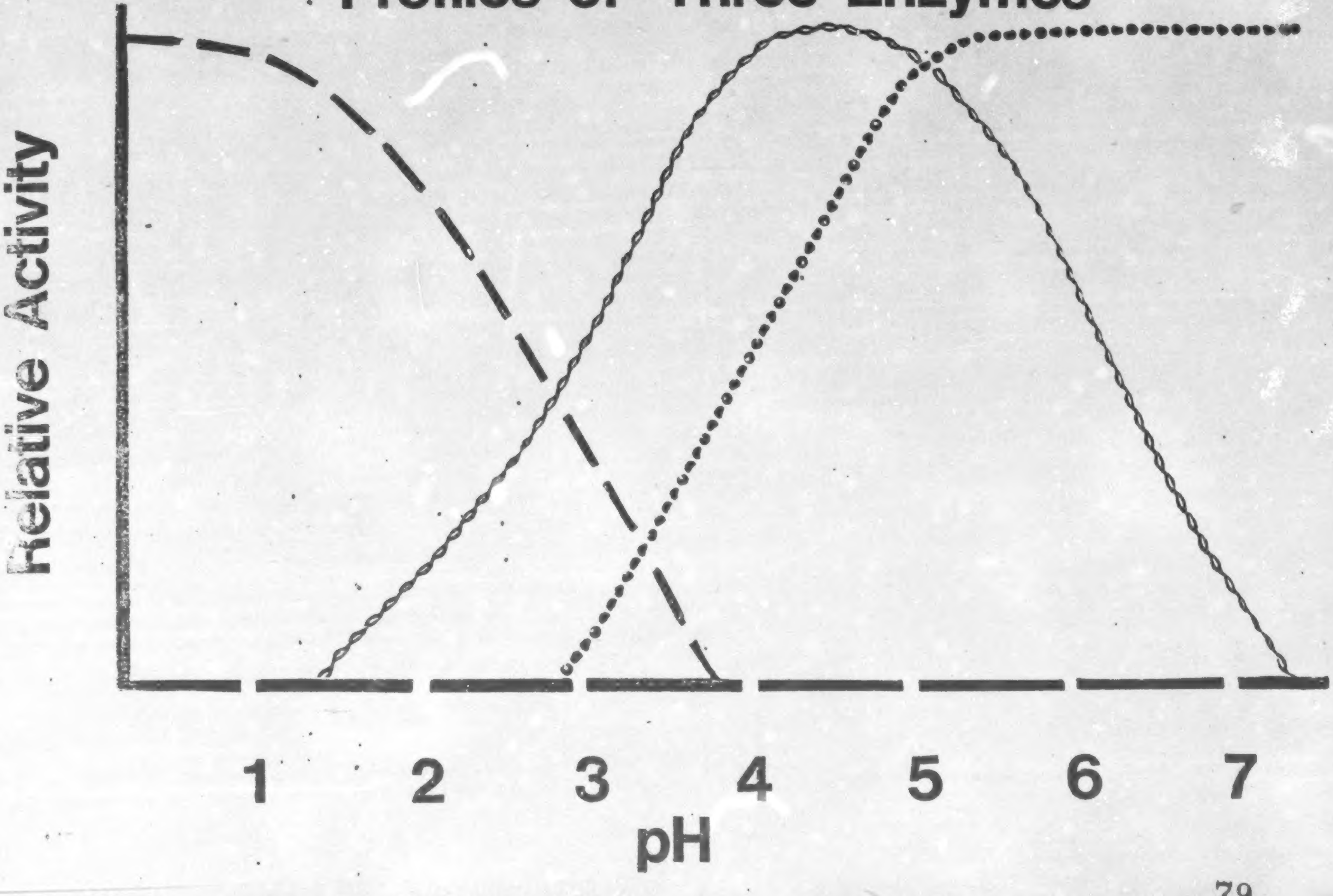A Comparison of the pH Activity Profiles of Three Enzymes